SARCOPTIFORMES (ACARI) OF SOUTH AUSTRALIAN SOILS.

3. ARTHRONOTINA (CRYPTOSTIGMATA)

by

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ABSTRACT

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A study of sarcoptiform mites from surface soil (usually greatest depth = 4 cm) at 9 florally diverse sites in South Australia is continued. Notations for hysteronotal fissures, kinds of gnathosoma, solenidia, form of notal setae and shield sculpturing are presented. Comments are made on the systematics of Macropylides in which the disbanding of the cohort Ptyctimina is supported. The included Arthronotina are divided into 3 new subcohorts: Monofissurae, Retrofissurae and Profissurae. A new family, Trichthoniidae, is established. A new name, *Neoliochthonius*, is given to *Paraliochthonius* Moritz not the pseudoscorpion genus *Paraliochthonius* Beier. New diagnoses are given for some superfamilies, families and genera. In this study, 11 species were collected. Two species are new: *Gehypochthonius strenzkei*, *Verachthonius moritzi*. Six species are newly recorded from Australia: *Hypochthoniella minutissima* Berlese, *Brachychochthonius elsosneadensis* (Hammer), *B. cricoides* Weis-Fogh, *Trichthonius pulcherrimus* (Hammer), *Phyllozetes emmae* (Berlese), *Sphaerochthonius splendidus* (Berlese). Three species were previously recorded from South Australia: *Cosmochthonius australicus* Womersley and 2 which were misidentified; *Liochthonius simplex* (Forsslund) as "*Brachychthonius* cf. *perpusillus*", *Liochthonius fimbriatissimus* (Hammer) as "*Brachychthonius* cf. *horridus*". The descriptions of 4 species not collected in this study are extended: *Gehypochthonius rhadamanthus* Jacot, *Hypochthoniella borealis* Jacot, *Poecilochthonius parallelus* (Womersley), *Liochthonius longipilus* (Womersley). *Cosmochthonius wallworki* and *Sphaerochthonius wallworki* are established for "*C.* sp." Wallwork and "*S.* sp." Wallwork. The synonymy of *Cosmochthonius domesticus* under *C. lanatus* by van der Hammen is revoked. Three subspecies of *Cosmochthonius* are given species status. New combinations are *Gehypochthonius urticinus* (Berlese) (ex *Parhypochthonius*), *Poecilochthonius parallelus* (Womersley) (ex *Brachychthonius*), *Liochthonius longipilus* (Womersley) (ex *Brachychthonius*), *Verachthonius montanus* (Hammer) (ex *Eobrachychthonius*) Besides 2 new identifications above, *Liochthonius ocellatus*: Hammer, 1958 is identified as *L. longipilus* (Womersley).

INTRODUCTION

This publication is part of a previously introduced study (Lee 1981) in which I indicated that I would follow Balogh's (1972) classification. However, although that classification is valuable because of its comprehensive nature, in dealing with the Macropylides or "Primitive Oribatei" it ignores parts of the published work of Grandjean and van der Hammen. In doing so it retreats from maturing the classification. Therefore, although this paper is primarily concerned with the Arthronotina, it includes a systematics section on the Macropylides in order to explain the higher classification used here, which is a modification of that presented by Grandjean (1969). Furthermore, higher taxa are given endings similar to those of Krantz (1978) in order to standardize the differentiation of each level. It should also be noted that, contrary to common practice amongst acarologists, other zoologists follow Simpson (1945) in regarding a cohort as a category between class and order rather than between order and family.

In order to examine the optical activity of some hairs, the Leitz microscope and interference contrast device T normally used was modified for use as a polarizing microscope by having a bright-field condenser disc and objectives so that no Wollaston prisms were in the beam path.

All material collected in this study is deposited in the South Australian Museum, Adelaide, unless stated otherwise.

NOTATION FOR MORPHOLOGY

The notation followed is as previously presented (Lee 1981), but comments are made below on the notation for hysteronotal fissures and shields, kinds of gnathosoma, solenidia, form of notal setae and shield sculpturing.

Hysteronotal Fissures and Shields

On most adult Cryptostigmata the hysteronotum is covered by a single continuous shield. The Arthronotina are unusual in that this integument is broken up into a series of shields separated by striated cuticle which when it forms a narrow strip is referred to as a fissure. In a description there is often a bias towards describing one or the other. Descriptions of the dorsal integument of Arthronotina are mainly biased towards

describing the transverse fissures. On the other hand, the lateral integument is usually described in terms of its shields. The latter can be confusing because a shield may be described as absent either because it is replaced by striated cuticle or because it is still present but is not separated from the rest of the notal shield by a fissure. The notation to be used is considered under two headings: *(a)* fissures, *(b)* shields (see also Fig. 1).

(a) Fissures. The signature "B" (initial letter of "break", "F" having already been allotted) will be used for a line separating one part of a shield from another part that is either a strip of striated cuticle or is regarded as representing what was a strip of striated cuticle in some allied species. Fissures are regarded as belonging to 5 categories: (i) *acutely hinged fissures,* with articulated sides capable of movement from a level position to enclose an angle of 80° to 140°; (ii) *hinged fissures,* with articulated sides only capable of movement to enclose an angle of 140° to 175°; (iii) *complete fissures,* with immovable sides completely dividing a shield into separate parts; (iv) *partial fissures,* not completely dividing shield into separate parts; (v) *relict fissures,* no strip of striated cuticle, but some demarcation furrow on shield representing a fissure. The taxonomically important fissures are the *transverse hysteronotal fissures* of which there is a maximum of 3 (*TB*1, *TB*2, *TB*3) each lying behind the same numbered seta in hysteronotal file *J*. There may be transverse lines behind seta *J*4 but these are not regarded as representing strips of striated cuticle. Only one lateral hysteronotal fissure is referred to: the *dorsolateral longitudinal fissure* (LB). This separates what are called pleural shields from the notal shields.

(b) Shields. On the hysteronotum there are a maximum four *notal* shields (*NS*1-4) and four *subnotal shields* (*SNS*1-4) numbered from the anterior. The subnotal shields have been referred to as "suprapleural" shields (Moritz 1976) but, since they sometimes merge with the notal shields as for example shield *SNS*1 which bears seta *S*1, I have preferred to relate them to the notal shield. Ventral to the dorsolateral longitudinal fissure are the *pleural shields* (*PS*1, 2) and *subpleural shields* (*SPS*1, 2).

Kinds of Gnathosternum

The 3 parts of the gnathosternum which contribute to its general shape are the palp coxites, external malae and mentum. In a few groups there is no mentocoxal fissure so that the precise border between the mentum and the palp coxites is not known. Grandjean (1957) regarded gnathosterna as belonging to 3 basic kinds (anarthric, stenarthric and diarthric), but I have found it more useful to directly describe the structures involved.

The following notation is introduced to describe the external malae and mentum. *Disjunct external malae* are well separated and lie either laterad or dorsolaterad to the internal malae and the bases of the preoral setae. *Conjunct external malae* lie ventrolaterad to the internal malae and the bases of the preoral setae, whilst a ridge indicates that the protruding parts of the palp coxites from which they originate come together midventrally behind the internal malae. *Coarctate external malae* abut ventrad to the preoral setae, obscuring them from view. An *undelineated mentum* has no distinct border with the palp coxites because there is no mentocoxal fissure, although, when this is true for members of the primitive beetle mites, the mentum is probably triangulate and sometimes ridges suggest its outline. A *triangulate mentum* is almost triangular in outline coming gradually to an anterior apex. The lateral margins lie well behind both this apex and the coxotrochanteral joint of the palps. A *quadrangulate mentum* is almost square or rectangular in outline, usually with a straight, transverse anterior margin. This shape results from a thickening of the lateral margins of the mentum so that its anterior shoulders move forward close to the coxotrochanteral articulation of the palps.

A general statement can be made that the gnathosterna of Cryptostigmata have evolved from those with disjunct external malae and an undelineated mentum to those with coarctate external malae and a quadrangulate mentum. The Arthronotina have either disjunct or conjunct external malae and an undelineated mentum.

Solenidia

Three of Grandjean's established terms for solenidia of certain shapes (*baculiform, ceratiform* and *piliform*) (see Norton 1977) are used below. The term "tactile" is replaced by *flagelliform* and the term *spiniform* is used for stout evenly tapering solenidia. Some solenidia are *coupled* with a seta, occupying the same alveolus, whilst others are either *associated* with a seta or well *separated* from any seta.

Although solenidia are usually dorsal, either 1 or 2 ventral solenidia have been recorded (Grandjean 1954b 1963, Covarrubias 1968, Reeves and Marshall 1971) on the tarsus I of some Brachychthoniidae, Protoplophoridae and Sphaerochthoniidae. In describing a new species of *Verachthonius* below these solenidia were examined with polarized light and appeared to fit the definition of solenidia, but are spiniform, which is not a shape found amongst dorsal solenidia. The symbol *sov* is used for these solenidia, and if in a pair the anterior one is numbered first.

Form of Notal Setae and Shield Sculpturing

In identifying the *Cosmochthonius* species collected in this study it was found that some attributes of the form of the notal setae and shield sculpturing had to be carefully delineated since these characters, which may be trivial and inaccurately described in some previous descriptions, had to be used because few other data were available.

In describing the long hysteronotal setae, seta *J*3 is always referred to and it is assumed that setae *J*4, *Z*3 and *Z*4 are similar unless otherwise indicated. The important attributes are the size and spacing of the marginal files of cilia on the setae. Cilia are regarded as *even* if each cilium is intermediate or equal in length to the cilia on either side of it, and *uneven* if this is not so. Cilia are *short* if less than diameter of setal mid rib, *medium-lengthed* if × 1-× 1.25 and *long* if more than × 1.25 this diameter. Cilia are *dense* if distance apart is less than diameter of setal mid rib, *medium-spaced* if × 1-× 1.25 and *sparse* if more than × 1.25 this diameter.

The notal sculpturing consists of pits or puncta which are described as *punctations* if circular or oval and *reticulations* if polygonal, the straight edges forming a network. Puncta are *large* if similar or greater in size to setal base *J*3, or *small*. Puncta are *abutting* if the space between them is not greater than × 0.5 each one's diameter, *close* if between × 0.5-× 1 and *well separated* if greater than this diameter.

SYSTEMATICS

Supercohort MACROPYLIDES

Remarks: Balogh (1972: 32) stated in referring to his classification "The . . . Primitive Oribatei or Macropylina is in complete accordance with van der Hammen's system (1959)." This is inaccurate. Van der Hammen (1959) has 7 groups as follows (with Balogh's grouping in parentheses): Palaeacaroidea (= Bifemoratina), Parhypochthonioidea (included in Arthronotina), Enarthronota including Protoplophoridae (Arthronotina and part of Ptyctimina), Mesoplophoroidea (= part of Ptyctimina), Phthiracaroidea (= part of Ptyctimina), Perlohmannioidea (= part of Holonotina) and Nothroidea including Nanhermanniidae and Hermanniidae (= part of Holonotina and part of the Apterogasterina in the Brachypylides or "Higher Oribatids"). Therefore, Balogh's classification differs in 2 important respects from that of van der Hammen: it ignores the rejection of the Ptyctimina as a valid group and changes the point of delineation of the Macropylides from the Brachypylides. Van der Hammen's classification reflects that of Grandjean who established both the Enarthronota (Grandjean 1947a: 215) with the *Protoplophora* included in it, and a classification (Grandjean 1954a: 428-431) which is a detailed precursor of van der Hammen's classification.

It is hard to understand how the Ptyctimina (recognisable by the adult being ptychoid i.e. having an acutely hinged prehysteronotal fissure) has survived as a taxon for so long. Grandjean (1933: 319) pointed out that *Mesoplophora* (ptychoid) has an adult gnathosternum remarkably like that of Hypochthoniidae (non-ptychoid) and should be grouped with that family rather than with the Phthiracaroidea (ptychoid). It appears that the belief that Grandjean's work is based on characters of immature stages which produce a "natural" but difficult classification to follow has inhibited the application of his work. For the Macropylides this had led to an unnecessary stagnation since much of Grandjean's classification is based on adult characters. Not that there is any basis for regarding adult characters as producers of an "artificial" classification. The disadvantage of Balogh's currently accepted classification of the Cryptostigmata seems to be that it was based on descriptions of adults which in many cases included too few characters.

Although the classification by Balogh (1972) is widely used and is included in a recent manual on mites (Krantz 1978) some specialists do follow Grandjean's work. Even then, there may be uncertainty as when Norton (1980), in referring to *Mesoplophora* and other ptychoid mites, states "these and several other *apparently* unrelated oribatid mites" (my italics).

The classification used in this publication follows the trend of Grandjean's (1969) work. The Ptyctimina are not regarded as a valid group. The Protoplophoroidea and Mesoplophoroidea (ex Arthroptyctima) are grouped in 2 different new subcohorts within the Arthronotina. The remaining majority within the disbanded Ptyctimina, the Phthiracaroidea and Euphthiracaroidea (ex Euptyctima), is grouped in the Holonotina which are not considered below.

Cohort ARTHRONOTINA

Diagnosis: Macropylides. Often pale, minute to medium-sized (790 or less) adults. One, 2 or 3 transverse hysteronotal fissures present (Mesoplophoridae appear to lack these fissures, but the presence of only 8 pairs of setae on notal shield indicates that shield's posterior edge represents fissure *TB*3, while posterior and pleural shields inconspicuously merged with ventral shields). External malae either disjunct or conjunct. Mentum undelineated. Femora not divided into 2 separate parts. Immatures similar to adults except sometimes in disposition of hysterosomal shields and always in chaetotaxy and nature of genital shields.

Remarks: The most conspicuous attribute of members of this cohort is the presence of transverse hysteronotal fissures breaking up the rigid integument into a number of separate shields. Just as the form of these fissures varies from a vague line to a hinged break in the soma, so do their functions probably also vary. In the case of *Elliptochthonius profundus* a fissure probably allows bending of the soma in order to negotiate narrow pore spaces in the deeper soil layers, whilst for *Protoplophora palpalis* it allows the back as well as the front of the mite to be folded down to form a protective ball. The advantage of the fissure is not so obvious for mites such as *Hypochthoniella minutissimus* and *Sphaerochthonius splendidus,* but possibly it allows expansion of the hysterosoma to accommodate a large egg.

The attributes of morphological characters in the Arthronotina vary considerably compared with those of the other 2 cohorts of Macropylides. This is the main reason for my establishing 3 new subcohorts within it. One, the Monofissurae, represents a well established taxon in that it includes only the Parhypochthonioidea. On the other hand, the Retrofissurae and Profissurae are entirely new taxa. It may prove preferable to downgrade these 3 subcohorts to superfamilies (Parhypochthonioidea, Mesoplophoroidea, Protoplophoroidea). However, for the time being, the novelty of the grouping, the strangeness of the 2 ex-Ptyctimina superfamily names being applied to much larger and diverse taxa, and my uncertainty as to the importance of the differences between Phyllochthonioidea and the other Retrofissurae, make my classification a reasonable stage in the maturing of the systematics of the cohort.

If the grouping into taxa that I have called the Retrofissurae and Profissurae survives, it will suggest a number of cases of parallel evolution: the folding-up-soma of the Mesoplophoridae and Protoplophoridae; the short, simple somal setae of the Brachychthoniidae and Haplochthoniidae; the long erectile mid-dorsal setae of the Trichthoniidae and Cosmochthoniidae; and the large toadstool-like dorsal setae of the Phyllochthoniidae and Pterochthoniidae.

The Arthronotina exhibit primitive attributes. On the other hand, I regard some attributes as specialised, such as slim setose external malae (e.g. *Heterochthonius gibbus*) and comb-like fixed cheliceral digits (e.g. *Pterochthonius angelus),* which are considered by Grandjean (1947b 1957) as reflections of the setal origins of these structures. Also, although the presence of hysteronotal fissures on all species reflects the primitive nature of the cohort, a greater number of fissures may not be an indication of a more primitive taxon.

The classification of the Arthronotina that I propose to use is outlined below.

A. **Subcohort**: Monofissurae
- **1. Superfamily:** Parhypochthonioidea
  Families: Parhypochthoniidae
  Gehypochthoniidae
  Elliptochthoniidae

B. **Subcohort**: Retrofissurae
- **1. Superfamily:** Hypochthonioidea
  Families: Hypochthoniidae
  Eniochthoniidae
  Brachychthoniidae
  Heterochthoniidae
  Trichthoniidae
- **2. Superfamily:** Mesoplophoroidea
  Families: Mesoplophoridae
  Archoplophoridae
- **3. Superfamily:** Phyllochthonioidea
  Families: Phyllochthoniidae
  Atopochthoniidae

C. **Subcohort:** Profissurae
- **1. Superfamily:** Cosmochthonioidea
  Families: Cosmochthoniidae
  Sphaerochthoniidae
  Pterochthoniidae
  Haplochthoniidae
- **2. Superfamily:** Protoplophoroidea
  Families: Protoplophoridae

KEY TO SUBCOHORTS OF ARTHRONOTINA (ADULTS)

1. Hysteronotal gland present. Only single transverse hysteronotal fissure (*TB*2) present. External malae conjunct. Both pairs of adanal pores (*Jaf, Zaf*) present. Genua of legs with 1 or 2 solenidia. Pretarsi with 3 claws (shorter central claw sometimes rudimentary) . . . . . Monofissurae

Hysteronotal gland absent. More than 1 transverse hysteronotal fissure (if only 1 is conspicuous it is either *TB*1 or *TB*3). External malae either disjunct or conjunct. Either 1 pair of adanal pores (*Zaf*) present or both pairs absent. Genua may have 0, 1 or 2 solenidia. Pretarsi with 1, 2 or 3 claws (if 3 claws then central 1 most robust) 2

2. Two (rarely only *TB*3) transverse hysteronotal fissures (*TB*2, *TB*3) so that both setae *J*1 and *J*2 on first shield (*NS*1/2) (an exception is Phyllochthonioidea, with toadstool-like dorsal setae, broad areas of striated cuticle on hysteronotum and

narrow first shield not bearing seta *J2*). External malae disjunct. Either 1 pair (*Zaf*) of adanal pores present or both pairs absent. At least genua of legs I and II have 1 or 2 solenidia. Pretarsi with either 1 or 2 subequal claws Retrofissurae

Three (rarely only *TB*1 obvious: *TB*2 obscure, *TB*3 absent) hysteronotal fissures (*TB*1, *TB*2, *TB*3) so that seta *J1* but not *J2* on first shield (*NS*1). External malae conjunct. No adanal pores. All genua without solenidia. Pretarsi with 1, 2 or 3 claws but if 2 claws present, 1 usually much slimmer and rarely on pretarsus IV Profissurae

Subcohort MONOFISSURAE n.

Diagnosis: Arthronotina. Single transverse hysteronotal fissure (*TB*2) complete or hinged. Hysteronotal gland with egress pore between setae *Z*4 and *Z*5. Cowl absent or rudimentary, enclosing only part of retracted chelicerae. Cheliceral digits unmodified, dentate. Cheliceral setae both (*ch*1, *ch*2) present and setose. Distal plasmic setae on palp tarsus simple not bifurcate. External malae conjunct. Two pairs of adanal pores (*Jaf, Zaf*) present. On tarsus I, seta *d*1 never simple, at least bifurcate. Genua of all legs with 1 or 2 solenidia. Pretarsi with 3 claws of which shorter central claw may be rudimentary.

Remarks: The Monofissurae is not a new taxon since it includes only the Parhypochthonioidea van der Hammen, 1959, with the following 3 monogeneric families: Parhypochthoniidae, Gehypochthoniidae, Elliptochthoniidae. Although Grandjean (1954a) separated the Parhypochthonioidea from what is here regarded as the rest of the Arthronotina, I prefer to follow Balogh (1972) in placing it in the Arthronotina, especially since the Elliptochthoniidae partly "closes the gap" between the 2 taxa. As 1 gehypochthoniid nymph was collected in the present study, that family is considered in more detail below. The 2 other families are considered briefly as follows. i) Parhypochthoniidae Grandjean, 1932b. Similar to Gehypochthoniidae especially in the general appearance of the gnathosoma. However it is easily distinguished from other Monofissurae by the egress pore of the hysteronotal gland being on an apophysis and by the presence of a setal file *Sa* which includes 4 setae. *Parhypochthonius* does have attributes in common with *Elliptochthonius* that do not occur on *Gehypochthonius*, such as 3 palpocoxal setae, hysteronotal seta *Z*4 present and a solenidium on tibia IV, but these are considered at the most to distinguish families. ii) Elliptochthoniidae Norton, 1975. When established it was suggested that this family may in the future have to be grouped in a separate superfamily. Amongst the combination of attributes used in the diagnosis, it should be noted that the hinged transverse hysteronotal fissure (which merges laterally with the ventral fissure immediately behind coxite IV so that the posterior part of the body is movable in relation to the anterior part) occurs on members of the *rhadamanthus*-complex in *Gehypochthonius*. Also used to diagnose the family was the gnathosoma which has a number of substantially modified characters considering that the Monofissurae occupies a primitive position in the classification. The external malae ventrally obscure much of the internal malae and their palpocoxal bases abut onto each other for almost their entire length. There is only one pair of adoral setae. The palp is reduced in that the trochanter and femur are fused and it carries few setae (1-0-2-7). The cowl is extensive, although not completely enclosing the retracted chelicerae. These gnathosomal attributes alone support the suggestion that this family may have to be grouped in a separate superfamily.

Family GEHYPOCHTHONIIDAE Strenzke

Gehypochthoniidae Strenzke, 1963: 251.

Type-genus: *Gehypochthonius* Jacot, 1936.

Remarks: The Gehypochthoniidae currently includes only *Gehypochthonius* so that most further points are made under that generic heading. *Gehypochthonius* and *Parhypochthonius* are closely allied. I would group Gehypochthoniidae under Parhypochthoniidae, but for the presence on *Parhypochthonius* of 4 setae in file *Sa*, which is regarded as important in representing a "preanal segment" (Grandjean 1954a) and is usually absent amongst the Arthronotina (exceptions: Pterochthoniidae and possibly Phyllochthonioidea).

GEHYPOCHTHONIUS Jacot

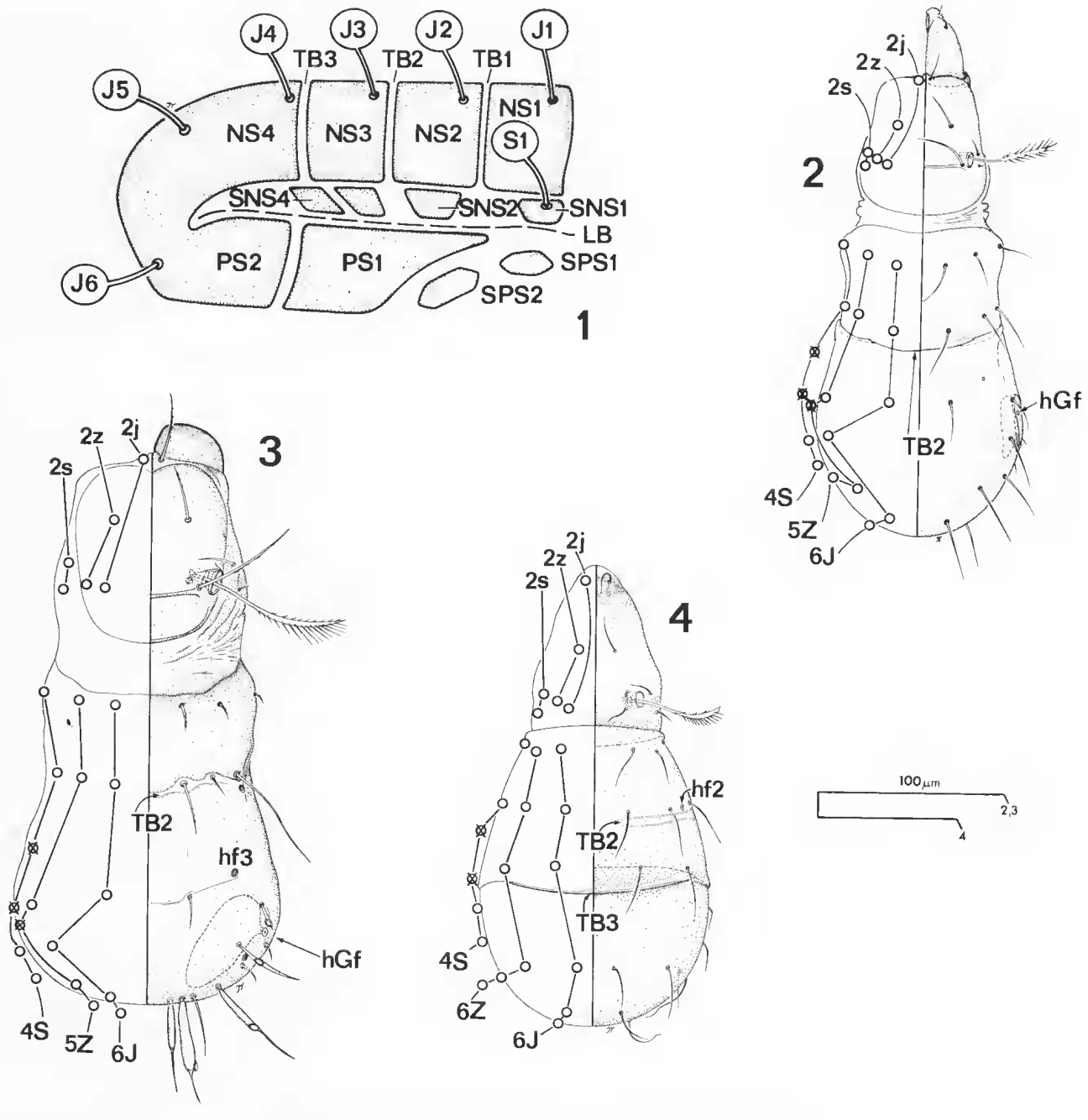
Gehypochthonius Jacot, 1936: 22. Type designation (original): "*Gehypochthonius rhadamanthus* sp.nov."

Type-species: *Gehypochthonius rhadamanthus* Jacot, 1936: 22.

Diagnosis: Monofissurae. Cowl absent. External malae conjunct. Adoral setal file includes 3 pairs, of which *ao*1 is either bifurcate or spreads out distally into a triangulate flap. Palpocoxal setal file includes 2 pairs. Adanal setal file *Sa* absent. Transverse hysteronotal fissure may or may not be hinged and merge with a ventral fissure. Hysteronotal seta *Z*4 absent (present on larva, see Strenzke 1963: fig. 20). No setae in adanal file *Sa*. Palp with 5 free segments and 2 setae on femur. On tarsus I, bifurcate seta *d*1 with 1 branch tapering and 1 expanded into an oval flap. Tibia IV without solenidia.

Morphology: Minute (250-380), pale ivory-white and sometimes partly straw-coloured, chelicerae light brown. Soma bulbous behind seta *J2* with clear, medium-lengthed refractile setae sticking out like spines. Legs I and IV longer than II and III, I stoutest.

Gnathosoma with conjunct external malae, internal malae not partially obscured ventrally. Leg coxites completely delineated by apodemes, although apodeme separating coxite III from IV sometimes broken.



FIGS. 1-4—Arthronotina: 1, signatures for hysteronotal shields and fissures; 2, *Gehypochthonius rhadamanthus* Jacot, adult, notum; 3, *Gehypochthonius strenzkei* n.sp., tritonymph, notum; 4, *Hypochthoniella minutissimus* Berlese, adult notum.

When transverse hysteronotal fissure hinged, anterior hysteronotum narrower at the fissure and fits into posterior hysteronotum. Similar to structure in *Elliptochthonius,* but not to equivalent fissures of most Arthronotina, where the posterior fits into anterior hysteronotum.

Chaetotaxy. Soma: 2*j,* 2*z,* 2*s;* 6*J,* 5*Z,* 4*S;* 3*ao,* 2*c,* 1*cd;* 3*I,* 1*Id,* 2*II,* 3*III,* 4*IV;* 5 to 8*Jg,* 3*Zg,* 2*Sg;* 2*Ja,* 3*Za,* 0*Sa.* Appendages: *ch*(2), *pa* (0-2-0 or 1-2-11), *I* (1-4 or 6-5-6-22), *II* (1-5-3 or 5-5 or 6-17), *III* (2-2 or 3-2 or 3-3 or 4-13 or 15), *IV* (1 or 2-2-1 or 2-3 or 4-11 or 13). Solenidia: *pa* (0-0-1), *I* (1 or 2-1-3), *II* (1-1-1 or 2), *III* (1-1-0), *IV* (1-0-0).

Hairs generally setose. Adoral seta *ao*1 either bifurcate or spreads out distally into triangulate flap, *ao*2 sometimes stout, blunt rod. Some somal and appendage setae with inconspicuous cilia; plasmic seta *z*2 has conspicuous cilia and take 1 of 2 forms described below under diagnoses of the 2 species-complexes. Posterior hysteronotal setae always tapering distally, but in some cases medially and proximally dilated into a refractile cylinder around a central canal. Some dorsal leg setae (as *G. xarifae*) lanceolate with lateral flaps. Tarsus I, with seta *d*1 short and bifurcate, 1 branch tapering and 1 ovate. If solenidia present on a tarsus or tibia at least 1 is ceratiform or baculiform. Solenidia of genua either piliform (sometimes slightly

blunter than surrounding setae and so approaching ceratiform) or flagelliform.

Distribution: Possibly cosmopolitan—Canada (Nn), Carolina and Florida (Na), France (Pe), Japan (Pc), Maldive Islands (Oc), Australia (Aa).

Remarks: The only species of *Gehypochthonius* described extensively enough to refer to the gnathosoma and appendages is *G. xarifae* Strenzke, 1963. Since the lateral view of the type-species (*G. rhadamanthus* Jacot, 1936: fig. 1) is similar to that of *Elliptochthonius*, I needed to establish whether or not these 2 species were congeneric, because, although the single tritonymph collected during this study is congeneric with *G. xarifae*, it was not certain if either species should be grouped in *Gehypochthonius*. Strenzke (1963: 248) has compared *G. xarifae* and *G. rhadamanthus*, referring to Grandjean's unpublished extensions of the description of *G. rhadamanthus* based on specimens collected in France, but at that time *Elliptochthonius* was not known.

To clarify the situation I examined both described and undescribed mites not collected in the present study. These, together with the material before me, confirm that *G. xarifae* and *rhadamanthus* are similar. However whilst regarding them as congeneric, I place them in separate species-complexes, pending upgrading or abandonment.

***rhadamanthus*-complex**

Diagnosis: Gehypochthonius. Smaller (250-275). Transverse hysteronotal fissure merges with ventral fissure and appears hinged. Plasmic seta *z*2 with short cilia (length × 2 or less of setal diameter). Hysteronotal seta *Z*2 more than × 0.5 length of *S*2. Hysteronotal seta *J*5 less than × 2 length of *J*3 and diameter never more than that of outer rim of alveolus. Setal file *Jg* with 5 or 6 setae. Adoral seta *ao*2 tapered as *ao*3. Appendage chaetotaxy reduced, for example no setae on genu of palp and only 3 setae on both tibiae III and IV. One solenidium on genu I. Solenidium on tibia III longer (at least × 1.1) than the tibia. Solenidium on genu IV about twice (× 1.9-2.1) length of the genu.

Remarks: As only 1 species is included, further information is under the species heading. As noted there, the species may be composite.

***Gehypochthonius rhadamanthus* Jacot**

(Fig. 2)

Gehypochthonius rhadamanthus Jacot, 1936: 22.
Gehypochthonius rhadamanthus Jacot: Aoki, 1975: 55.

Adult

Idiosomal length 250-275 (Carolina—255, N.S.W.—250, Japan—262-275). Main cheliceral axis apparently at less than 45° angle from horizontal somal axis even in unsquashed specimens. Apodeme separating coxite III from IV broken. Specimen from Japan atypical (as original description) in that seta *Z*2 longest in second rank. Seta *J*5 slimmest on Carolina specimens and stoutest (equal in diameter to its alveolus) on N.S.W. specimens. Specimen (Fig. 2) from Carolina differs compared with those from other localities in that setae *J*6 and *Z*6 displaced forward.

Chaetotaxy of soma varies in that file *Jg* has 6 setae on Carolina and Japanese specimens and 5 setae on N.S.W. specimens. Chaetotaxy of appendages (N.S.W. adults, and same on femora, genua and tibiae of Carolina adults): *pa* (0-2-2-11), *I* (1-4-5-6-22), *II* (1-5-3-5-17), *III* (2-2-2-3-13), *IV* (1-2-1-3-11).

Material examined: Twenty-five syntypes ("cotypes", 34F23.2-5, Smithsonian Institution, U.S.A.) from Carolina on single slide. One adult (Ac8636, National Science Museum, Tokyo, Japan) from Japan. Three adults (N19794-N19796), litter and soil, open *Eucalyptus* forest, Cordeaux (34° 08'S, 150° 43'E), New South Wales, Australia, 9.6.1978, T. Moulton.

Specimens from N.S.W. well cleared but squashed, and characters of gnathosoma and appendages (some presented under genus heading) clearly discernible. Syntypes in good condition yet poorly cleared and sometimes shrivelled. Most characters of gnathosoma and appendages discernible, but chaetotaxy of appendages only confirmed on femur, genu and tibia, and for solenidia alone on tarsi. Specimen from Japan poorly cleared and shrivelled. Many characters of gnathosoma and appendage chaetotaxy not discernible, but attributes of transverse hysteronotal fissure, seta *Z*2 and solenidia on tibia III and genu IV justify its inclusion in this species-complex.

Distribution: Widespread—Carolina (Na), France (Pe), Japan (Pc), Australia (Aa). The majority of specimens examined by Jacot (1936) were from 5-12.5 cms deep in the soil. Records of other specimens are from soil or plant litter under shrubs or trees.

Remarks: G. rhadamanthus, with a hinged transverse hysteronotal fissure and simpler setae, appears adapted to live in deeper soil layers than its congeners and therefore superficially resembles *Elliptochthonius* species. If the morphological variations of this widespread species later prove to reflect distinct species, and the above diagnosis for the *rhadamanthus*-complex remains valid, I would recommend that the genus be limited to this complex alone.

***xarifae*-complex**

Diagnosis: Gehypochthonius. Bigger (290-380). Transverse hysteronotal fissure not merging with a ventral fissure and not hinged. Plasmic seta *z*2 with long cilia (length of longest × 5 or more of setal

diameter). Hysteronotal seta *Z*2 less than × 0.5 length of *S*2. Hysteronotal seta *J*5 either more than × 2 length of *J*3 or its diameter in parts greater than that of outer rim of its alveolus, or both attributes present. Setal file *Jg* with 7 or 8 setae. Adoral seta *ao*2 blunt, spindle-shaped or parallel-sided rod. Appendage chaetotaxy not so reduced, for example 1 seta on palp genu and 4 setae on both tibiae III and IV. Two solenidia on genu I. Solenidium on tibia III shorter (at most × 0.9) than tibia. Solenidium on genu IV conspicuously shorter than twice (× 1.5 or less) length of genu.

Material examined: Specimens of new species below. Holotype of *G. frondifer* from Japan (Ac8567, National Science Museum, Tokyo, Japan); notum uppermost, slightly shrivelled, only partially cleared and including 2 substantial opaque food boli, some attributes difficult to discern.

Distribution: Widespread—Florida (Na), Maldive Islands (Oc), Australia (Aa). From moss or plant litter under shrubs or trees.

Remarks: Although little is known about *Parhypochthonius urticinus* Berlese 1910a: 219 and fig. 43, the dorsum of the female illustrated with egg is so similar to that of members of this complex that it is here included in *Gehypochthonius*.

Four species are included in the *xarifae*-complex: *G. frondifer* Aoki, 1975; *G. strenzkei* **n.sp.**, *G. urticinus* (Berlese, 1910a) **n.comb.**, *G. xarifae* Strenzke, 1963.

Gehypochthonius strenzkei n.sp.

(Fig. 3)

Tritonymph

Idiosomal length 290 (1); appendage lengths—*ch* 27.5, *pa* 55, *I* 125, *II* 95, *III* 95, *IV* 120; femur breadths—*pa* 12.5, *I* 25, *II* 15, *III* 15, *IV* 15. Transverse hysteronotal fissure (*TB*2) indistinct, bearing setae *J*2 and *Z*2, (fissure *TB*2 of adults set behind these setae). Indistinct disc around the hysteronotal gland pore (*hGf*) not illustrated. No indication of vestigial presence of seta *Z*4. Five hysteronotal setae (*J*4, *J*5, *J*6, *Z*3, *Z*5) have swollen, refractile zone, but not setose seta *Z*6. Four of these 5 setae (all but *J*6), on right side only, bear a ring-like refractile structure, only present on seta *J*5 on left side. Opisthosternal chaetotaxy: 5*Jg*, 3*Zg*, 2*Sg*, 2*Ja*, 3*Za*, 0*Sa*. Gnathosoma similar to that of adult *G. xarifae* except adoral seta *ao*1 bifurcate with 2 tapering branches that lack joining hyaline flap. Appendage chaetotaxy and solenidiotaxy includes 6 setae on femur I and 4 setae on genu II but otherwise matches that of tritonymph of *G. xarifae*. On genu IV, dorsal seta simple and short (× 0.5 length of genu).

Adult

Idiosomal length about 350 (2—very squashed). Similar to tritonymph except adult attributes as in *G. xarifae*. There are further differences. Plasmic seta *z*2 with 11 cilia in long-cilia file as adult *G. xarifae*, but not its own tritonymph and *G. frondifer* which have 14 or 15 such cilia. Some posterior hysteronotal setae swollen and refractile as tritonymph, but lack ring-like structures and have relatively longer slim, tapering tips on some setae (*J*5, *J*6, *Z*5). Appendage chaetotaxy and solenidiotaxy as adult *G. xarifae* except only 1 seta on trochanter IV as tritonymph of *G. strenzke* and *xarifae*. Differs from its own tritonymph in having 5 setae on genu II. Dorsal setae on legs tend to be short and simple compared with long lanceolate equivalent setae on adults of *G. xarifae*, for example, on genu IV where solenidium about × 1.2 length of genu, associated seta about × 0.5 length of genu (on *G. xarifae* solenidium about equal to length of genu, associated seta about × 1.6 length of genu with hyaline flap so that lanceolate).

Material examined: Holotype tritonymph (N19797), litter and sparse grass, under *Acacia sophorae*, Piccaninnie Ponds, 3.7.1974, D. C. Lee. Two females (N19798 and N19799), litter and soil, open *Eucalyptus* forest, Cordeaux (34° 08′S, 150° 43′E), New South Wales, Australia, 9.6.1978, T. Moulton.

Distribution: Australia (Aa). New South Wales: sclerophyll forest, Great Dividing Range. South Australia: Piccaninnie Ponds, coastal closed-scrubland, 1TN (-/8).

Remarks: G. strenzkei is based on 1 tritonymph collected as part of this study, supported by what are regarded as conspecific adults from N.S.W. Certain characters, such as the number of cilia on plasmic seta *z*2, suggest that the adults may belong to a separate closely allied species. But the ring-like refractile structures, which are not bilaterally symmetrical in their distribution amongst some hysteronotal setae of the tritonymph, are regarded as a non-inherited attribute.

The shape of the posterior hysteronotal setae clearly distinguishes *G. strenzkei* from *urticinus* and *xarifae* on which such setae are much longer and slimmer. Because *G. xarifae* is fully described, differences in leg chaetotaxy and shape of hairs on leg IV have been referred to above, but this is not possible for *G. urticinus*. The hysteronotal setae are much more similar to those of *G. frondifer*, for which I was unable to establish the leg chaetotaxy or shape of hairs on leg IV. The main attribute I use to distinguish this species from *G. frondifer*, is the setose hysteronotal seta *Z*6. On *G. frondifer* seta *Z*6,

although smaller, is distinctly swollen like *J6*. Furthermore, although not conspicuous, the swollen hysteronotal setae such as *J5* on *G. frondifer* are more curved in outline with a shorter tapered tip.

Subcohort RETROFISSURAE n.

Diagnosis: Arthronotina. Usually 2 transverse hysteronotal fissures *(TB2, TB3)*, sometimes obscure as when hysteronotal setae so far towards anterior that seta *J4* set well within anterior half of hysteronotum (Heterochthoniidae) or when notal setae broadly lanceolate, spatulate or umbellate and extent of notal shields considerably reduced (Phyllochthonioidea), or only 1 fissure *(TB3)* present when prehysteronotal fissure acutely hinged (Mesoplophoroidea). No hysteronotal gland with egress pore between setae *Z4* and *Z5*. Cowl present, enclosing retracted chelicerae. Cheliceral digits usually unmodified, sometimes edentate. Cheliceral setae both usually present and setose, sometimes *ch*1 absent, rarely *ch*2 enlarged, lanceolate. One distal plasmic seta on palp tarsus usually bifurcate, no such seta longer than tarsus. External malae disjunct. Either 1 pair *(Zaf)* of adanal pores present or both pairs absent. On tarsus I, seta *d*1 simple or bifurcate. At least genua I and II with 1 or 2 solenidia. Pretarsi with either 1 claw or 2 subequal claws.

Remarks: The Retrofissurae is a new taxon. It is very diverse in form and, as pointed out above in the remarks on the cohort, the variations reflect similar variations in the Profissurae suggesting the parallel evolution of the 2 groups. The name Retrofissurae is intended to indicate a main attribute that contrasts with the Profissurae, i.e. that the transverse hysteronotal fissures are usually more posterior, fissure *TB*1 not being represented. The most heavily weighted attribute in this study is the presence of disjunct external malae, a possibly primitive condition also found in the Bifemoratina, but not elsewhere amongst the Cryptostigmata. On the other hand, certain species (see *Trichthonius pulcherrimus* below) have a conspicuously modified gnathosoma. The presence of solenidia on leg genua is an attribute common amongst Cryptostigmata, contrasting with their absence on members of the Profissurae. Attributes of the adult claws also appear to be a reliable diagnostic feature although there are exceptions and they diagnose lower taxa amongst some other groups of Cryptostigmata. The correlation of the attributes of these 4 characters, with few exceptions, is considered here as a good case for a new splitting of a large part of the Arthronotina into the Retrofissurae and Profissurae.

The Retrofissurae includes 3 superfamilies: Hypochthonioidea Balogh, 1961; Mesoplophoroidea van der Hammen, 1959; Phyllochthonioidea Travé, 1967. The Hypochthonioidea include most members of this subcohort, and since some were collected in this study, they are considered further below. The Mesoplophoroidea, which only include 2 genera and about 7 species, were considered briefly by myself (Lee 1981) under the now disbanded Arthroptyctima. The Phyllochthonioidea are considered below in these remarks, although none were collected in this study.

The superfamily Phyllochthonioidea Travé, 1967: 103 is a group of minute (length 200-340) pale mites with large dilated umbellate dorsal setae. *Atopochthonius artiodactylus* Grandjean, 1948 was described as the type and only species of Atopochthoniidae with a Holarctic distribution across southern Canada (Nn), Mediterranean region (Pm) and forest zones of Western Europe (Pe), as far as the Altai Mountains in Mongolia (Ps). A second species *(Phyllochthonius aoutii* Travé, 1967) from the Ivory Coast (Ew) was established as the type of Phyllochthoniidae. This family has since been recorded from broad-leaved forests in southern Eurasia (Ps) and the far east of the U.S.S.R. (Ps). The 2 genera are similar in appearance although their chaetotaxy differs. For example, *A. artiodactylus* has a gnathosoma very similar to that of *P. aoutii*, but lacks 2 setal pairs *(ao*1, c1*p)*. The hysterosomal chaetotaxy is confused because Grandjean (1948) regards seta *J2* as absent so that the large erectile seta (third in file *J*) is labelled "*f*1", whilst Travé (1967) labels it "*e*1". There are more hysterosomal setae on *P. aoutii* and, if Grandjean (1948) is correct in considering the second hysteronotal rank to be absent, then setal file *Sa* is present on this species. It may prove preferable to group these 2 genera in 1 family, but for the time being I have retained both families because the presence or absence of setal file *Sa* has in the past been given considerable weight on the basis that it reflects the presence or absence of a "preanal segment" (see above remarks on Gehypochthoniidae).

The Phyllochthonioidea are unusual in their attributes of 2 of the 4 characters which are weighted in the diagnosis of Retrofissurae and this makes its grouping with the other 2 superfamilies questionable. The 2 attributes are that there is a fissure *(?TB*1*)* close behind seta *J*1 and the pretarsus has 2 claws rather than 1 claw. But it should be noted that the hysteronotal shields are considerably reduced and that the 2 claws are stout and symmetrical, whilst, when 2 claws are present on Profissurae species, they (one known exception) are assymmetrical with 1 hyaline and slim as for the lateral claws of allied species and the other refractile and stout as for the central claw (rarely the 2 claws are more similar in girth, in which case the slimmer claw is ciliate).

Superfamily HYPOCHTHONIOIDEA

Diagnosis: Retrofissurae. Prehysteronotal fissure not acutely hinged. Two narrow transverse fissures *(TB2,*

*TB*3) dividing hysteronotal shield into 3 parts. Dorsolateral longitudinal fissure *(LB)* anterior to seta *J5* delineates dorsal margin of pleural shield, ventrally separate from aggenital and adanal shields. Notal setae rarely broadly umbellate with *J*3 extending beyond posterior edge of soma, if so then ciliate. Pretarsus with 1 claw.

Remarks: The Hypochthonioidea as used here is a more extensive superfamily than as delineated by Balogh (1972) and includes 5 families: Hypochthoniidae Berlese, 1910a; Eniochthoniidae Grandjean, 1947a; Brachychthoniidae Thor, 1934; Heterochthoniidae Grandjean, 1954a; Trichthoniidae **n.f.** The Hypochthoniidae and Heterochthoniidae were not represented in collections for this study and are not further considered.

Family ENIOCHTHONIIDAE Grandjean

Eniochthoniinae Grandjean, 1947a: 223.

Type-genus: *Hypochthoniella* Berlese, 1910a.

Remarks: The Eniochthoniidae currently include only *Hypochthoniella* so that most further points are made under that generic heading. The family is closely allied to the Hypochthoniidae. These 2 families are usually regarded as the only members of the Hypochthonioidea.

HYPOCHTHONIELLA Berlese

Hypochthoniella Berlese, 1910a: 218. Type designation (original): *"H. (Hypochthoniella) pallidulus* K.", misidentification of *Hypochthonius minutissimus* Berlese, 1903 subsequently indicated as type (van der Hammen 1959: 17).

Arthrochthonius Ewing, 1917: 130. Type designation (original): *"Hypochthonius pallidulus* Koch", misidentification as type designation for *Hypochthoniella.*

Eniochthonius Grandjean, 1933: 32. Type designation (original): *"Eniochthonius pallidulus* (Mich.)", *Hypochthonius pallidulus* Koch: Michael, 1888: 537 syn. with *Hypochthonius minutissimus* Berlese, 1903 (see van der Hammen 1959: 17).

Type-species: *Hypochthoniella minutissima* (Berlese, 1903: 252).

Diagnosis: Hypochthonioidea. Minute (280-385), pale mites. Anterior of 2 transverse hysteronotal fissures (*TB*2) relict, not continuous across mid-notal line and conspicuously closer to seta *J*2, than seta *J*3, posterior fissure (*TB*3) about halfway between seta *J*1 and *J*6. Anterior part of pleural shield (*PS*1) not separated off by vertical fissure level with transverse hysteronotal fissure *TB*3. Hysteronotal setae *J*3 and *Z*3 subequal in length to setae *J*2 and *Z*2, setose and never longer than distance between setal bases *J*1 and *J*3. Hysteronotal seta *S*2 not as near to mid-notal line as *Z*1. Pair of merged coxites III and IV also merge with each other across mid-sternal line. No proteronotal eye or eyes in zone between setae *j*1 and *z*1. On tarsus I, bifurcate seta *d*1 with 1 branch tapering and 1 expanded into small disc. Adoral file includes 3 setae of which *ao*2 has distal teeth.

Material examined: Other than the specimens of *H. minutissima,* 1 syntype of *H. borealis* ("cotype", 37F1w-4, Smithsonian Institution, U.S.A.) from New Hampshire on a slide. This specimen slightly curled up, dorsal surface uppermost, well cleared and despite granular integument most attributes of dorsal and ventral surfaces distinguishable except on gnathosoma. Probably female since positor has long distal setae.

Distribution: Widespread in temperate regions (Nn, Na; NTc; Em; Pe, Pm, Ps, Pc; Os; Aa, An) with some indication that its members commoner in fermantation or deeper soil layers, where there is a substantial leaf-litter layer as in forests, woodland or scrubland.

Remarks: The most data on *Hypochthoniella* is to be gleaned from Grandjean's work (see below) on the type-species. The brief description of *H. borealis* clearly distinguishes it from the type-species, stating that it is larger (about 385) and has a notal plasmic seta *z*2 with only 4 or 5 short cilia (their length is about half that of the broadest width of the seta). I was uncertain as to whether or not *H. borealis* was grouped in the correct genus, but the disposition of somal shields is very much as on *H. minutissima* and both species have a large pore posterior to the acetabulum for leg IV.

Two species are included in *Hypochthoniella: H. minutissima* (Berlese, 1903); *H. borealis* (Jacot, 1939).

Hypochthoniella minutissima (Berlese)

(Fig. 4)

Hypochthonius pallidulus Koch: Michael, 1888: 537.

Hypochthonius minutissimus Berlese, 1903: 252.

Hypochthonius (Hypochthoniella) pallidulus Koch: Berlese, 1910a: 218

Eniochthonius pallidulus: Michael not Koch: Grandjean, 1933: 32.

Eniochthonius grandjeani van der Hammen, 1952: 13.

Female

Dull ochre, becoming orange at shield edges. Integument appears granular even in well cleared specimens. Refractile parts (external malae, cheliceral extremities, setae and claws) at least as pale as general integument. Idiosomal length 315 (25 ex Piccaninnie Ponds, 280-360); appendage lengths (for 320 not containing an egg)—*ch* 20, *pa* 50, *I* 115, *II* 110, *III* 95, *IV* 115; femur breadths—*pa* 10, *I* 17.5, *II* 17.5, *II* 17.5, *III* 15, *IV* 15. Prehysteronotal fissure appears

hinged and expandable so that, in relation to hysterosoma, propodosoma can move up and down through about 10°, and backwards and forwards over about 20μm. Anterior transverse hysteronotal fissure (*TB*2) relict, appearing to be shallow furrow on inner surface of integument. Posterior transverse hysteronotal fissure (*TB*3) hinged. In specimen illustrated (Fig. 4), posterior edge of anterior shield consists of both dorsal complete line and ventral broken line level with seta *J*3, whilst anterior edge of the posterior shield (which can be in forward position, level with seta *J*3) in backward position level with dorsal posterior edge of anterior shield. Specimens contain up to 3 food boli, anterior 1 usually diffuse, including what appears to be fungal hyphae and spores. All positors observed have stout long distal setae as on females with eggs, so all adults regarded as female. Amongst 25 registered females examined in detail, 15 without eggs, whilst 10 contain single large (length about 130) ellipsoidal egg. Average length of females with eggs 10 greater than those without.

Material examined: Twenty-five females (N1979150-N1979174), litter and sparse grass, under *Acacia sophorae*, Piccaninnie Ponds, 3.7.1974 and 20.8.1975, D. C. Lee. One female (N1979175), litter and sparse moss, under *Eucalyptus incrassata*, Ferries-McDonald, 20.6.1974, D. C. Lee. One female (N1979176), litter and sparse moss, under *Eucalyptus obliqua*, Mt Lofty, 9.5.1974, D. C. Lee.

Distribution: Widespread, as for genus. South Australia: Ferrries-McDonald, mallee-broombush open-scrubland, 1 (1/8); Piccaninnie Ponds, coastal closed-scrubland, 60 (6/8); Mt Lofty, sclerophyll open-forest, 1 (1/8).

Remarks: Confusion over the nomenclature relating to this species and its genus results from *Hypochthonius pallidulus* Koch, 1836: 3 (20) being the nymph of *H. rufulus* Koch, 1836: 3 (19) (syn. Grandjean 1933: 32), whilst *H. pallidulus* Koch: Michael, 1888: 537 is *Hypochthoniella minutissima*.

The most informative descriptions of *H. minutissima* (as *Eniochthonius pallidulus)* are by Grandjean: development of ventral region of soma (Grandjean 1933) development of lateral region of soma (Grandjean 1934); structure of seta *d*1 on tarsus I (Grandjean 1941); setation of genua (Grandjean 1942); gnathosoma (Grandjean 1957); solenidiotaxy (Grandjean 1964). The external morphology of this species, and so this family, is still incomplete in that for example, the leg chaetotaxy is not fully described.

Family BRACHYCHTHONIIDAE Thor

Brachychthoniidae Thor, 1934: 115.

Type-genus: *Brachychthonius* Berlese, 1910a.

Diagnosis: Hypochthonioidea. Minute (130-270), pale mites. Two complete transverse hysteronotal fissures (*TB*2, *TB*3), anterior fissure (*TB*2) never conspicuously closer to seta *J*2 than to *J*3, posterior fissure (*TB*3) about halfway between seta *J*1 and *J*6 or posterior to that position. Anterior part of pleural shield (*PS*1) separated off by vertical fissure level with transverse hysteronotal fissure *TB*3. Hysteronotal setae *J*3 and *Z*3, not more than × 1.5 length of setae *J*2 or *Z*2, setose, ciliate or lanceolate and never longer than distance between setal bases *J*1 and *J*3. Hysteronotal seta *S*2 as near to mid-notal line as *Z*1 or nearer. Pair of merged coxites III and IV do not merged with each other across mid-sternal line. No proternotal eye or eyes in zone between setae *j*1 and *z*1. On tarsus I, seta *d*1 simple. Adoral file usually includes 1 seta (*ao*2), reduced seta *ao*3 rarely present (*Neobrachychthonius*).

Material examined: Other than species collected during present study, brachychthoniid mites previously recorded from South Australia (Womersley 1945) also considered. Two species represented in both collections, 2 in Womersley's work alone and 3 in just this study, making 7 species altogether.

Distribution: Widespread, probably cosmopolitan (Niedbala 1972b 1977, Chinone 1978) and in wide variety of habitats especially moss, plant litter, and soil.

Remarks: The Brachychthoniidae are by far the largest family in the Arthronotina whilst exhibiting relatively little morphological diversity. Balogh (1972) included 5 genera. I follow a classification of European brachychthoniids (Moritz 1976a, 1976b) including 10 genera which, although it may be excessively divided, works well in classifying the material before me. One problem in classifying brachychthoniids is that the descriptions of many included species are too brief. For example, the leg chaetotaxy is known for very few species, as tabulated with the redescription of *Brachychochthonius lydiae* by Reeves and Marshall (1971), which refers to all of the more complete descriptions of brachychthoniids.

Niedbala (1972a, 1973) recognised 7 genera amongst which he attempted to establish phylogenetic relationships. *Eobrachychthonius* was regarded as the most primitive because of its 4 subnotal shields, whilst other genera were more or less advanced depending on the degree of either loss or fusion of these shields with the notal shield or each other. Furthermore, the family was regarded as having evolved along 2 branches: *Poecilochthonius* and *Synchthonius* constituting a minor branch in which a furrow indicates the line of merging of 2 subnotal shields (*SNS*2 and *SNS*3). The similarities of *Poecilochthonius* to *Brachychochthonius* and of *Synchthonius* to *Liochthonius* were regarded as "convergent similarity" and not due to "ways of evolution".

I have found it useful to newly group the 10 genera of Brachychthoniidae in 3 genus-eomplexes as follows:

1) *Brachychthonius*-complex— *Brachychochthochnius* Jacot, 1938; *Brachychthonius* Berlese, 1910a; *Eobrachychthonius* Jaeot, 1936; *Poecilochthonius* Balogh, 1943.

2) *Liochthonius*-complex—*Liochthonius* van der Hammen, 1959; *Mixochthonius* Niedbala, 1972a; *Synchthonius* van der Hammen, 1952; *Verachthonius* Mortitz, 1976a.

3) *Neobrachychthonius*-complex— *Neobrachychthonius* Moritz, 1976b; *Neoliochthonius* **n. name** (for *Paraliochthonius* Moritz, 1976a).

The genera are eonsidered below only if their representatives have been eolleeted in South Australia, on the other hand all the genus-eomplexes are considered. The 2 characters heavily weighted in diagnosing the genus-complexes are the presence or absence of a fissure separating off the anterior subnotal shield (*SNS*1) and the position of hysteronotal seta *Z*2. Normally the position of the anterior 2 ranks of hysteronotal setae of Arthronotina is that the 3 files are well spaced and sub-parallel, but in the Brachychthoniidae, seta *S*2 is always displaced towards mid-notal line, whilst *Z*2 is sometimes similarly displaeed.

Key to Genera of Brachychthoniidae

1. Hysteronotal seta *Z*2 displaced towards mid-notal line, base at least × 2 its own diameter away from line joining setae *S*2 and *Z*3. Anterior subnotal shield (*SNS*1) may or may not be separate from hysteronotal shield 2

   Hysteronotal seta *Z*2 not displaeed towards mid-notal line, base on or elose to line joining setae *S*2 and *Z*3. Anterior subnotal shield (*SNS*1) separate from hysteronotal shield. *Brachychthonius*-complex 3

2. Anterior subnotal shield (*SNS*1) separate from hysteronotal shield. *Neobrachychthonius*-complex 6

   Anterior subnotal shield (*SNS*1) merged with hysteronotal shield. *Liochthonius*-complex 7

3. Longitudinal furrow delineates, without separating off, marginal parts of hysteronotal shield bearing setae *Z*1, *S*2, *Z*2, *Z*3, *Z*4. Four separate subnotal shields present. Adanal seta *Za*2 eonspicuously stouter than *Za*1 and *Za*3. Pair of merged coxites III and IV also merge with each other aeross mid-sternal line *Eobrachychthonius*

   No such longitudinal fissure on hysteronotal shield as above. Two or 3 separate subnotal shields present. Adanal setae *Za*1 and *Za*2 similar, either both slim like *Za*3 or both stout. Pair of merged eoxites III and IV separated by fissure along mid-sternal line 4

4. Adanal setae in file *Za* similarly slim, although *Za*2 may be slightly longer than other 2 setae *Brachychthonius*

   Anterior 2 adanal setae in file *Za* eonspieuously longer and/or stouter than *Za*3 5

5. Three subnotal shields (*SNS*4 present). Adanal seta *Ja*1 on striated eutiele or narrow oval shield *Brachychochthonius*

   Two subnotal shields (*SNS*4 absent). Adanal seta *Ja*1 on broadly triangulate shield *Poecilochthonius*

6. Two palpocoxal setae (*c*1*p* absent). Adoral seta *ao*2 tapers to distal end. Proteronotal plasmic seta *z*2 broadens distally into a subspherieal ciliate ball. Subnotal shield *SNS*3 merges with hysteronotal shield *Neoliochthonius*

   Three palpoeoxal setae (*c*1*p* present). Adoral seta *ao*2 stout and distally dilated. Seta *z*2 broadens distally into oval ciliate ball with longitudinal axis at least × 2 greatest transverse axis. Subnotal shield *SNS*3 separate from hysteronotal shield *Neobrachychthonius*

7. Subnotal shield *SNS*3 merges with hysteronotal shield or absent. Posterior setae in hysteronotal file *J* spaeed normally, *J*6 nearly level with *Z*6 in relation to posterior margin of hysteronotal shield. Adoral seta *ao*2 slim and tapering *Liochthonius*

   Subnotal shield *SNS*3 separate from hysteronotal shield. Posterior setae in hysteronotal file *J* almost as *Liochthonius* or eompaeted forward, *J*6 level with point midway between *Z*5 and *Z*6 in relation to posterior margin of hysteronotal shield. Adoral seta *ao*2 laneeolate or parallel sided with blunt distal end 8

8. Hysteronotal setae conspicuously ciliate. Seta *J*6 more nearly level with seta *Z*6 in relation to posterior margin of hysteronotal shield than to point midway between *Z*5 and *Z*6. Adoral seta *ao*2 broadly laneeolate *Mixochthonius*

   Hysteronotal setae never conspicuously ciliate. Seta *J*6 nearly level to point midway between *Z*5 and *Z*6 in relation to posterior margin of hysteronotal shield. Adoral seta *ao*2 parallel sided with blunt distal end 9

9. Adanal seta *Za*2 eonspicuously longer and stouter than *Za*1 and *Za*3. Three setae in aggenital setal file *Jg* (*Jg*4 absent). Two setae on both genu III and IV *Synchthonius*

   Adanal seta *Za*2 and *Za*1 similar, either both slim or both stout, although *Za*2 may be slightly longer. Four setae in aggenital setal file *Jg* (*Jg*4 present). Three setae on both genu III and IV *Verachthonius*

BRACHYCHTHONIUS-eomplex

Diagnosis: Braehyehthoniidae. Anterior subnotal shield (*SNS*1), bearing seta *S*1, separate from hysteronotal shield. Hysteronotal setae *Z*1, *S*2, *Z*2 and*Z*3 in nearly straight line parallel to lateral margin of notal shield beeause seta *Z*2 not displaced towards mid-notal line. Subnotal shield *SNS*3 separate from hysteronotal shield. Adoral seta *ao*2 parallel-sided with blunt distal end. Three setae on both genu III and IV (1 ventral seta present). Coxite IV bearing 4 setae.

Remarks: The *Brachychthonius*-complex is made up of 2 groups: *Eobrachychthonius* and the other 3 genera. *Eobrachychthonius* is not elosely allied to the other genera, but it is useful to group them together because of the similar position of hysterononta seta *Z*2, 1 of the most important characters referred to in the briefer deseriptions. *Eobrachychthonius* is hardly sculptured at all on its notum, but its hysteronotal shields have a marginal strip delineated by a furrow. The other 3 genera usually have strongly sculptured hysteronotal shields with a marginal ridge. Possibly these 2 types of marginal zonation are reflected in the similar lack of displacement of seta *Z*2 towards the mid-notal line so that it remains on the margin. The marginal ridges also appear in this genus-complex to be correlated with the position of the posterior setae in file *J*, since they often end posteriorly in a

pair of tubercles bearing setae *J6*, which in turn are usually more anteriorad, file *J* being compacted forward.

Eobrachychthonius montanus Hammer, 1952 does not fit into that genus nor the rest of this genus-complex, but is tentatively newly combined below with *Verachthonius*.

Four genera are included in the *Brachychthonius*-complex: *Brachychthonius* Berlese, 1910a; *Brachychochthonius* Jacot, 1938; *Eobrachychthonius* Jacot, 1936; *Poecilochthonius* Balogh, 1943. Only *Brachychochthonius* and *Poecilochthonius* have been collected in South Australia and are considered below.

BRACHYCHOCHTHONIUS Jacot

Brachychochthonius Jacot, 1938: 130. Type designation (original): "*Brachychochthonius jugatus* sp.nov.".

Sellnickochthonius Krivolutsky, 1964: 935. Type designation (original): "*Brachychthonius zelawaiensis* Sellnick".

Brachychthonius Berlese: Chinone and Aoki, 1972: 223 (in part). Type indication: "*Brachychthonius berlesei* Willmann, 1928", correct identification of "*B. brevis* (Mich)": Berlese 1910a (see van der Hammen 1959: 19).

Type-species: *Brachychochthonius jugatus* Jacot, 1938: 130.

Diagnosis: *Brachychthonius*-complex. Hysteronotal shields without marginal longitudinal furrows, so that shield bearing setae *Z1*, *S2*, *Z2*, *Z3* and *Z4* not delineated from more central part. Three subnotal shields (*SNS1*, *SNS3*, *SNS4*) separate from hysteronotal shields. Pair of merged coxites III and IV separated by fissure along mid-sternal line. Adanal seta *Ja1* on striated cuticle or narrow oval shield. Anterior 2 adanal setae in file *Za* conspicously longer and/or stouter than *Za3*. Posterior setae in hysteronotal file *J* compacted forward so that *J6* level with seta *Z5* in relation to posterior margin of hysteronotal shield.

Distribution: Widespread, probably cosmopolitan.

Remarks: *Brachychochthonius* species separate out best under *Sellnickochthonius* in the keys of Balogh (1972). It is difficult to establish how many nominal species should be included in this genus because a number of possible members are known only by characters of their notal surface, which is insufficient to distinguish them from *Brachychthonius* and *Poecilochthonius*. Also, in the comprehensive list by Niedbala (1972), species of these 3 genera are all grouped in *Brachychthonius*. When Moritz (1976b) established the concept off this taxon as used here, he included 12 species from Europe and later Chinone (1978) included a further 5 species from Japan also *Brachychochthonius lydiae* Jacot from North America is returned to this genus. Therefore, with at least 18 species, it may be the largest genus in the *Brachychthonius*-complex. Two species (*B. elsosneadensis* and *B. ericoides*) in *Brachychochthonius* have been collected in South Australia and are considered below.

Brachychochthonius elsosneadensis (Hammer)

(Fig. none)

Brachychthonius elsosneadensis Hammer, 20.

Brachychthonius elsosneadensis Hammer: Chinone and Aoki, 1972: 229.

Female

Shields either dull orange or almost straw-coloured or pale ivory white. Darker orange specimens sometimes with adhesive, dirty exudate conspicuous at posterior end of soma. Idiosomal length 165 (25 ex Piccaninnie Ponds, 142.5-177.5); appendage lengths (for 165 not containing egg)—*ch* 5, *pa* 20, *I* 47.5, *II* 40, *III* 45, *IV* 57.5; femur breadths—*pa* 5, *I* 14, *II* 11, *III* 11, *IV* 13. Adults from Mt. Lofty and Knott Hill with idiosomal length within 162.5-182.5. All positors observed appeared similar to those of specimens containing egg, therefore all adults regarded as female. Amongst 25 females (ex Piccaninnie Ponds), 8 included 1 or 2 boli. Boli light or dark brown, homogeneously granular, level with or posterior to genital shields. Nine included single ellipsoidal egg with length within 70-92.5. Females with eggs appeared fatter but not longer than those without egg.

Material examined: Twenty-five females (N1979177-N1979201), litter and sparse grass, under *Acacia sophorae*, coastal scrubland, Piccaninnie Ponds, 3.7.1974 and 20.8.1975, D. C. Lee. Five females (N1979202-1979206) litter and sparse moss, under *Eucalyptus obliqua*, Mt. Lofty, 9.5.1974, D. C. Lee. Five females (N1979207-N1979211) litter, under *Pinus pinea*, Knott Hill, 22.5.1974, D. C. Lee.

Distribution. Argentina (NTc), Japan (Pe), South Australia (Aa). South Australia: Piccaninnie Ponds, coastal closed-scrubland, 35 (8/8); Mt. Lofty, sclerophyll open-forest, 13 (4/8); Knott Hill, cultivated pine forest, 6 (2/2).

Remarks: As the hysteronotal setae *J1* and *J2* are setose, they differ from the larger seta *J3* that has lateral hyaline flaps giving it a lanceolate shape, which distinguishes *B. elsosneadensis* from all other possibly congeners except *B. elisabethae* (Mahunka, 1974: 211) from Rhodesia (Ee). *B. elsosneadensis* is distinguishable from *B. elisabethae* in having a conspicuous hysteronotal pore *hf1* and narrower (breadth:length=0.3 or less:1) seta *J3*.

Brachychochthonius cricoides (Weis-Fogh)

(Fig. none)

Brachychthonius cricoides Weis-Fogh: 1948: 269.

Brachychthonius cricoides Weis-Fogh: Evans, 1952: 236.

Brachychochthonius cricoides (Weis-Fogh: Moritz, 1976b: 287).

Female

Shields pale straw-coloured. Idiosomal length 142.5 (5 ex Mt. Lofty and Knott Hill, 135-147.5); appendage lengths (for 145 ex Mt. Lofty)—*ch* 7.5, *pa* 20, *I* 45, *II* 40, *III* 42.5, *IV* 47.5; femur breadths—*pa* 6.25, *I* 10, *II* 8.75, *III* 8.75, *IV* 10. Specimens from Knott Hill have weak notal sculpturing, only a faint ridge associated with setal file *J*, a scalloped transverse ridge between tubercles bearing setae *J*6, and a line between setae *z*1 and *s*1. Specimens from Mt. Lofty have more complex notal sculpturing as illustrated for this species by Moritz, 1976b, but not as conspicuous as for *B. elsosneadensis*. Hysteronotal pore *hf*1 large, with conspicuous encircling refractile ring. One pale homogeneous granular bolus observed. Positors relatively small, involuted tubes forming a ring (diameter 10-12.5). No eggs seen, all adults assumed female.

Materials examined: Three females (N1979212-N1979214); litter and sparse moss, under *Eucalyptus obliqua*, sclerophyll forest, Mt. Lofty, 9.5.1974, D. C. Lee. Two females (N1979215, N1979216), litter, under *Pinus pinea*, Knott Hill, 22.5.1974, D. C. Lee.

Distribution: Denmark, Czechoslovakia, England, Germany, Italy, Sweden, Poland (Pe); Asiatic USSR (Ps); South Australia (Aa). South Australia: Mt. Lofty, scleropyll open-forest, 3 (2/8); Knott Hill, cultivated pine forest, 2 (1/2).

Remarks: B. cricoides is minute and pale, with faint sculpturing, short setose notal setae and a very conspicuous hysteronotal pore (*hf*1). The following 5 species are similar: *B. aokii* (Chinone, 1974); *B. jacoti* (Evans, 1952); *B. miyauchii* Chinone, 1978; *B. rotundatus* Hammer, 1958; *B. suecicus* Forsslund, 1942. B. cricoides is more precisely distinguishable in that it has rostral teeth, lacks fine punctuations in the median delineated areas of the proteronotal sculpturing, proteronotal seta *z*1 is without cilia and hysteronotal setae are short (*J*2 is about 0.35 × the distance between its bases; *J*3 is about 0.75 × the distance between its bases).

POECILOCHTHONIUS Balogh

Poecilochthonius Balogh, 1943: 22. Type designation (original): "*Poecilochthonius italicus* (Berl.)".

Poecilochthonius Balogh: Moritz, 1976b: 248.

Type-species: *Poecilochthonius italicus* (Berlese, 1910a: 220).

Diagnosis: Brachychthonius-complex. Hysteronotal shields without marginal longitudinal furrows, so that shield bearing setae *Z*1, *S*2, *Z*2, *Z*3 and *Z*4 not delineated from more central part. Two subnotal shields (*SNS*1, *SNS*3) separate from hysteronotal shields. Pair of merged coxites III and IV separated by fissure along mid-sternal line. Adanal seta *Ja*1 on broadly triangulate shield (width of broad anterior end = × 2.5 length of *Ja*1). Anterior 2 adanal setae in file *Za* conspicuously longer and/or stouter than *Za*3. Posterior setae in hysteronotal file *J* compacted forward, so that seta *J*6 in zone (breadth = × 0.5 distance *Z*5-*Z*6) centred on point midway between *Z*5 and *Z*6 in relation to posterior margin of hysteronotal shield.

Distribution: Widespread. Greenland (Nn); Argentina (NTc); Austria, Germany, Hungary (Pe); Italy, Yugoslavia (Pm); Japan (Pc); South Australia (Aa).

Remarks: Poecilochthonius species separate out to the couplet including *Brachychthonius* and *Synchthonius* in the key of Balogh (1972). No mites in the present study are grouped in this genus, but a species has been recorded from South Australia. Moritz (1976b) excludes 1 species, *Brachychochthonius hungaricus* (Balogh, 1943), originally included in this genus.

Three species are included in *Poecilochthonius: P. italicus* (Berlese, 1910a); *P. parallelus* (Womersley, 1945) **n. comb.**; *P. spiciger* (Berlese, 1910a).

Of the 2 specimens of *P. parallelus* from South Australia referred to by Womersley (1945), only the holotype (N1979297) has been found. Even after remounting, it remains strongly squashed around an axis that cuts through the region of setal file *S* on 1 side and *Za* and *Zg* on the other side. Despite this, 3 characters were observed on 1 side: subnotal shield *SNS*4 is absent; shield bearing seta *Ja*1 is broadly triangulate; adanal setae *Za*1 and *Za*2 are similar to each other and conspicuously stouter than *Za*3. Attributes of the hysteronotal sculpturing which gave rise to the name *parallelus* (i.e. the straight median and lateral ridges almost devoid of sculpturing in between) distinguish this species from its congeners.

***LIOCHTHONIUS*-complex**

Diagnosis: Brachychthoniidae. Anterior subnotal shield (*SNS*1), bearing seta *S*1, merged with hysteronotal shield. Hysteronotal setae *Z*1, *S*2, *Z*2 and *Z*3 not in nearly straight line parallel to lateral margin of notal shield because seta *Z*2 displaced towards mid-notal line. Subnotal shield *SNS*3 separate, merged with hysteronotal shield or absent. Adoral seta *ao*2 either parallel sided with blunt distal end, setose or lanceolate. Two or 3 setae on either genu III or IV (ventral seta present or absent). Coxite IV bearing 4 setae.

Remarks: Except for *Synchthonius*, members of the *Liochthonius*-complex are hardly sculptured at all on their dorsal integument. *Synchthonius* does have seta *Z*2 displaced towards mid-notal line as on the unsculptured genera, but seta *J*6 is displaced anteriorad as for the sculptured genera of the *Brachychthonius*-complex. *Verachthonius* also has an anteriorad displacement of seta *J*6, although species have an almost smooth dorsal integument. Yet, there is a lateral ridge posteriorly around setae *Z*5 and *S*5, and sometimes a fainter 1 reaching *J*6. Possibly this ridge indicates that ancestors of this genus were more sculptured with the anteriorad displaced seta *J*6 on a tubercle.

Four genera are included in the *Liochthonius*-complex: *Liochthonius* van der Hammen, 1959; *Mixochthonius* Niedbala, 1972a; *Synchthonius* van der Hammen, 1952; *Verachthonius* Moritz, 1976a. Only *Liochthonius* and *Verachthonius* have been collected in South Australia and are considered below.

LIOCHTHONIUS van der Hammen

Brachychthonius Berlese: Strenzke, 1951: 235. Type indication: none, but 8 of 12 included species grouped in *Liochthonius* by Moritz (1976a), other 4 species not in *Brachychthonius*. Assume original designation of "*B. brevis* Mich.", although misidentification (Berlese, 1910a) of *Brachychthonius berlesei* Willmann, 1928 (Type of *Brachychthonius* Berlese, 1910a).

Liochthonius van der Hammen, 1959: 19. Type designation (original): "*Brachychthonius perpusillis* (redescription by Forsslund, 1942, p. 4, fig. 4)".

Liochthonius van der Hammen: Moritz, 1976a: 38. Type indication: "*Hypochthonius brevis* Michael, 1888 non Berlese 1910" (syn. *Brachychthonius perpusillus* Berlese, 1910a).

Type-species: *Liochthonius brevis* (Michael, 1888: 539).

Diagnosis: Liochthonius-complex. No subnotal shields separate from hysteronotal shields. Hysteronotal setae never conspicuously ciliate. Posterior setae in hysteronotal file *J* not conspicuously compacted forward, seta *J*6 nearer level of seta *Z*6 than point midway between *Z*5 and *Z*6 in relation to posterior margin of hysteronotal shield. Notal shields relatively smooth with few scattered circular markings. Only adoral seta (*ao*2) setose, tapering to distal point. Adanal seta *Za*2 conspicuously longer and stouter than other 2 setae (*Za*1, *Za*3). Three setae on both genu III and IV (ventral seta present). Aggenital file *Jg* with 4 setae (*Jg*4 present).

Distribution: Widespread, probably cosmopolitan.

Remarks: Liochthonius separates out correctly in the key of Balogh (1972). Species of all genera without a sculptured notum and with a centralward displaced seta *Z*2 have until recently (1972 and after) been grouped in *Liochthonius* despite the fact that, amongst a number of differences from the type of that genus, they have at least 1 separate subnotal shield: either *SNS*1 (*Neoliochthonius*) or *SNS*3 (*Mixochthonius*, *Verachthonius*) or both (*Neobrachychthonius*). This illustrates the fact that many brachychthoniids have until recently been classified on the basis of only a dorsal view of their soma. On the other hand, because of the strongly sculptured notal shields, the type of *Synchthonius* was previous grouped in *Brachychochthonius*, despite a centralward displaced seta *Z*2.

Niedbala (1972b) included 40 species in *Liochthonius*, but it is difficult to establish for certain how many nominal species should now be included in this genus. Moritz (1976a) includes 22 species from Europe and Chinone (1978) includes some of these plus a further 8 species from Japan. So that, with a minimum of 30 nominal species at the moment, it is likely that this is the largest genus in the Brachychthoniidae.

Niedbala (1977) used 37 morphological characters to calculate values of similarity amongst 19 species of *Liochthonius*. Whilst these species clustered into 4 separate groups, Niedbala concluded that establishing subgeneric taxa would be excessive splitting of the genus.

Moritz (1976a) divided *Liochthonius* into 4 species-complexes, which do not correspond to the groups noted by Niedbala (1977) and are mainly delineated by attributes of the notal setae. I have found it useful to use these species-complexes and a derivation from Moritz's key is presented below.

Key to species-complexes of *Liochthonius*

1. Hysteronotal setae broad, similar breadth to plasmic proteronotal seta *z*2 (*J*1 = × 0.75-× 1.25 *z*2) *horridus*-complex

   Hysteronotal setae setose, conspicuously slimmer than dilated distal half of plasmic proteronotal seta *z*2 (*J*1 = less than × 0.75 *z*2) 2

2. Plasmic proteronotal seta *z*2 distally spindle-shaped, with single terminal point and bearing 3 to 5 lateral files of 4 to 8 cilia *brevis*-complex

   Plasmic proteronotal seta *z*2 distally bearing 2 lamellae, each with separate terminal point and 16 to 20 small marginal cilia 3

3. Notal setae mostly (always *z*1 and *J*3) setose, rounded in transverse section *penduncularis*-complex

   Notal setae mostly (always *z*1 and *J*3) lanceolate, with narrow lateral lamellae, V-shaped in transverse section *lapponicus*-complex

Members of the *lapponicus*-complex have not been collected in South Australia. Species of the *brevis*-complex and *horridus*-complex have been collected in the present study and are considered below, 1 species under each species-complex heading. A single species in the *penduncularis*-complex was collected previously from South Australia and is considered in the remarks on that species-complex.

***brevis*-complex**

Liochthonius simplex (Forsslund)

(Fig. none)

Brachychthonius simplex Forsslund, 1942: 7.
Brachychthonius cf. *perpusillus* Berl.: Womersley, 1945: 219.
Liochthonius simplex (Forsslund): Moritz, 1976a: 50.

Female

Shields straw-coloured. Idiosomal length 162.5 (25 ex Knott Hill, 155-170); appendage lengths (for 162.5)—*ch* 14, *pa* 35, *I* 85, *II*55, *III* 50, *IV* 75; femur breadths—*pa* 8, *I* 13, *II* 11, *III* 11, *IV* 13. Specimens from Mt. Lofty similar in size, but 5 specimens from Normanville (Womersley 1945) sometimes larger (idiosomal length 152.5-205, previously recorded as 235, Womersley 1945), probably because squashed. No specimens contain eggs. Proteronotal plasmic setae *z*2 bears 5 lateral files of 4 to 6 cilia.

Material examined: Twenty-five females (N1979272-N1979296), litter, under *Pinus pinea*, Knott Hill, 22.5.1974; D. C. Lee. Five females (N1979298-N1979302) litter and sparse moss, under *Eucalyptus obliqua*, Mt. Lofty, 9.5.1974, D. C. Lee. Five females (N1979303-N1979307) form Normanville (Womersley 1945).

Distribution: Greenland (Nn); Czechoslovakia, England, Finland, Germany, Hungary, Poland, Sweden (Pc); Bulgaria (Pm); Asiatic USSR (Ps); Japan (Pc); South Australia (Aa). South Australia: Mt. Lofty, sclerophyll open-forest, 61 (6/8); Knott Hill, cultivated pine forest, 113 (2/2); Normanville (Womersley 1945).

Remarks: Moritz (1976a: 41) comments on *L.* cf. *perpusillus* (Berlese: Womersley, 1945) under *Liochthonius brevis* (Michael, 1888) stating that it is larger than the latter and with distinctly shorter dorsal setae. While I agree that this material should be grouped in the *brevis*-complex, Womersley's (1945) measurements for it are misleading and it fits better under *L. simplex* than *L. brevis* according to Moritz's (1976a) own descriptions. It should be noted that the proteronotal plasmic seta has to be examined carefully, since at certain angles it can appear to have the attributes of the *lapponicus*-complex, in which case this species might be grouped under *L mollis* (Hammer, 1958). Regarding the description of *L. simplex* by Chinone (1974), this appears to fit the description of *L. leptaleus* Moritz, 1976a rather than that of *L. simplex*.

***horridus*-complex**

Liochthonius fimbriatissimus (Hammer)

(Fig. none)

Brachychthonius cf *horridus* Sellnick: Womersley, 1945: 220.
Brachychthonius fimbriatus Hammer, 1958: 14 (not Jacot, 1936: 248).
Liochthonius fimbriatissimus Hammer, 1962: 15.
Liochthonius fimbriatissimus Hammer: Hammer, 1966: 13.

Female

Shields straw-coloured. Idiosomal length 170 (25 ex Piccaninnie Ponds, 162.5-185); appendage lengths (for 177.5)—*ch* 13, *pa* 35, *I* 72.5, *II* 60, *III* 60, *IV* 75; femur breadths—*pa* 10, *I* 17, *II* 14, *III*14, *IV* 16. Form of some notal setae difficult to assess. Some notal setae (*j*1, *z*1, *J*6, *Z*6, *S*6) lanceolate with smooth-edged hyaline flaps. Other setae (e.g. *J*2-*J*5) appear similar, but hyaline flap sometimes wrinkled so that edge looks serrate. In contrast, seta *S*1 has hyaline flap of 1 side broken up into file of 6 distinct cilia. Other setae lanceolate in outline, but uncertain if edge ciliate or wrinkled. Positors present in all specimens examined and assumed females although no eggs seen. Of 25 specimens ex Piccaninnie Ponds, 16 contain 1 or 2 boli made up of material including distinct cellular forms.

Material examined: Twenty-five females (N1979218-N1979242), litter and sparse grass, under *Acacia sophorae*, coastal scrubland, Piccaninnie Ponds, 3.7.1974, D. C. Lee. Five females (N1979243-N1979247), litter and sparse moss, under *Eucalyptus incrassata*, Ferries-McDonald, 20.6.1974, D. C. Lee. Five females (N1979248-N1979252), litter, under *Banksia ornata*, Tamboore, 4.7.1974 D. C. Lee. Five females (N1979253-N1979257) litter and sparse moss, under *Eucalyptus obliqua*, Mt. Lofty, 9.5.1974, D. C. Lee. Five females (N1979258-N1979262), litter, under *Pinus pinea*, Knott Hill, 22.5.1974, D. C. Lee. Seven females (N1979263-N1979271) from Normanville (Womersley 1945).

Distribution: Argentina (NTa), Tierra del Fuego (Sm), New Zealand (An), South Australia (Aa). South Australia: Ferries-McDonald, mallee-broombush open-scrubland, 6 (3/8); Tamboore, mallee-heath tall open-shrubland, 68 (6/8); Piccaninnie Ponds, coastal closed-scrubland, 658 (8/8); Mt. Lofty, sclerophyll open-forest, 45 (4/8); Knott Hill, cultivated pine forest, 216 (2/2); Normanville (Womersley 1945).

Remarks: The leg 1 of *L. fimbriatissimus* is shorter and stouter than that of *L. simplex* described above. The top end of the range of idiosomal lengths given for *L. fimbriatissimus* (ex Piccaninnie Ponds) is probably too high since the specimens all belonged to a group which had been in lactic acid for a long time and were distended with extended ehelicerae.

Moritz (1976a: 99) pointed out that *L.* cf *horridus* (Sellnick: Womersley, 1945) has shorter and stouter setae than *L. horridus* (Sellnick, 1928) and he excluded if from *L. horridus*. This material has been newly identified here as *L. fimbriatissimus* and the

many specimens from the present study have been similarly identified. They all look very much more like the illustration of this species (Hammer 1958: fig. 2) from Argentina rather than Womersley's illustration (Womersley 1945: fig. 1D-G). Hammer (1958) does figure the notal setae as almost parallel-sided compared to the more convex edges of those of the South Australian specimens, but this may result from the lateral hyaline flaps being angled up at their edges.

***pedunculuris*-complex**

Remarks: Members of the *pedunculuris*-complex were not collected in this study. On the other hand, *Liochthonius longipilus* (Womersley, 1945: 220) **n.comb.** from Normanville, South Australia (holotype, N1979308; paratypes N1979309-N1979314) is grouped in this species-complex. The illustration (Womersley 1945: fig 11) of the proteronotal plasmic seta *z*2 is inaccurate; it should be as for this species-complex. The following 2 more recently described species are very similar and 1 or both may be synonymous with *L. longipilus*.

Liochthonius ocellatus: (Hammer, 1958: 19) (**newly identified** as *L. longipilus*) from Argentina is not *L. ocellatus* (Hammer, 1952: 19) (syn. *L. hystricinus* by Moritz, 1976a: 66) from Canada. The subcircular markings and other characters on the notal surface of *L. longipilus* are similar to those illustrated for the Argentinian specimens. Therefore, since the Argentinian material has no valid name it is provisionally grouped under *L. longipilus*.

Liochthonius perfusorius Moritz, 1976a: 93 from Germany is very similar to *L. longipilus* although there are fewer notal markings illustrated.

VERACHTHONIUS Moritz

Verachthonius Moritz, 1976a: 112. Type designation (original): *"Brachychthonius laticeps* Strenzke, 1951".

Type-species: *Verachthonius laticeps* (Strenzke, 1951: 240).

Diagnosis: Liochthonius-complex. One subnotal shield (*SNS*3)separate from hysteronotal shield. Hysteronotal setae never conspicuously ciliate. Posterior setae in hysteronotal file *J* conspicuously compacted forward seta, *J*6 nearly level to point midway between *Z*5 and *Z*6 in relation to posterior margin of hysteronotal shield. Notal shields relatively smooth with few ridges or circles, usually 1 ridge runs from anterior notch between posterior notal and pleural shields back to region of seta *Z*5. Only adoral seta (*ao*2) stout, almost parallel-sided with blunt tip. Adanal setae *Za*1 and *Za*2 similar, either setose like seta *Za*3 or conspicuously stouter than *Za*3. Three setae on both genu III and IV (ventral seta present). Aggenital file *Jg* with 4 setae (*Jg*4 present).

Distribution: Canada (Nn), Argentina (NTc), Germany (Pe), Japan (Pc), Australia (Aa).

Remarks: Verachthonius species separate out to the couplet including *Brachychthonius* and *Synchthonius* in the key of Balogh (1972). But, because the descriptions of many species are mainly based on a dorsal view of the soma, any such incorrectly placed species of *Verachthonius* would probably be currently included in *Liochthonius* rather than *Brachychthonius* or *Synchthonius*.

Verachthonius montanus (Hammer, 1952: 17) from Canada and Argentine (Hammer 1958: 19), was included in *Eobrachychthonius* but on criteria used here it clearly belongs in the *Liochthonius*-complex and in either *Liochthonius* or *Verachthonius*. My most heavily weighted attribute for supporting its inclusion in *Verachthonius* is the forward displacement of seta *J*6.

Five species are included in *Verachthonius: V. congruus* Moritz, 1976a; *V. diversus* Moritz, 1976a; *V. laticeps* (Strenzke, 1951); *V. montanus* (Hammer, 1952), **n.comb.**; *V. moritzi* **n.sp.**

Verachthonius moritzi n.sp.

(Figs. 5-13)

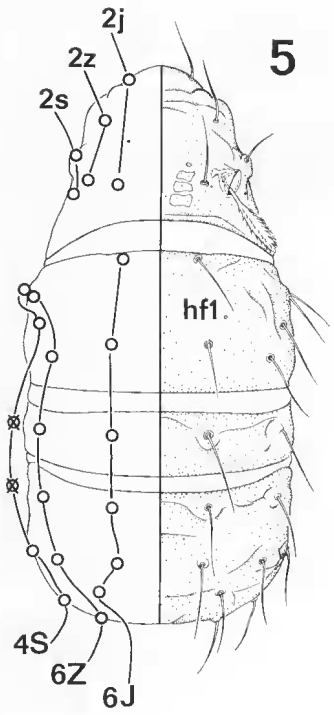
Female

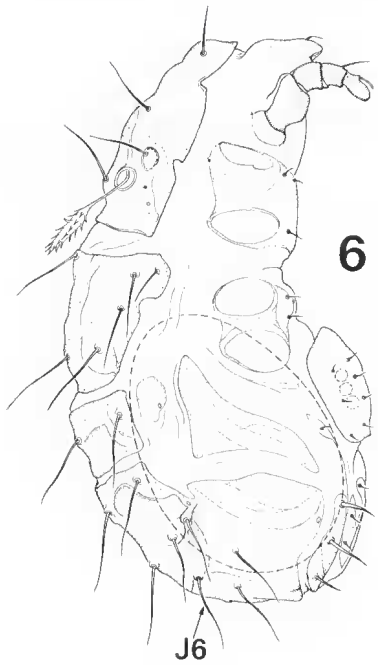
General appearance: Shields straw-coloured. Idiosomal length 157.5 (20, 145-165); appendage lengths (for holotype, 152.5)—*ch* 10, *pa* 32.5, *I* 62.5, *II* 47.5, *III* 47.5, *IV* 62.5; femur breadths—*pa* 9, I 14, *II* 11, *III* 10, *IV* 11.

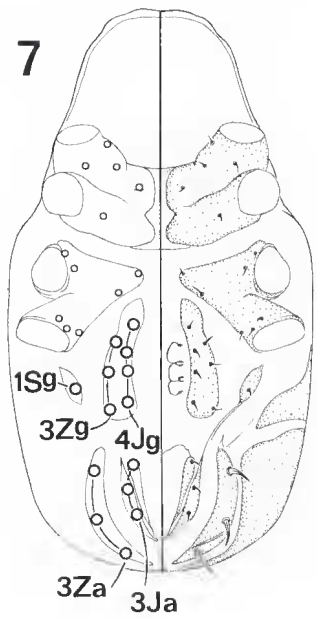
Prosternum: Gnathosoma illustrated either dorsoventrally squashed (Fig. 9) or laterally squashed so chelicerae unnaturally extended (Fig. 6). Single adoral seta (*ao*2) nearly parallel-sided for entire length, slightly spread out at blunt distal tip. External malae refractile and colourless. Coxites III and IV of each side clearly separated by mid-sternal fissure, but not established whether or not trough between coxites I and II occupied by striated cuticle.

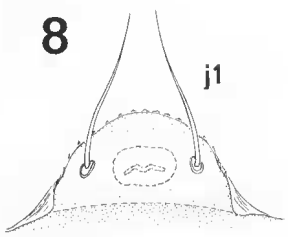
Proteronotum: Single refractile recess under cowl shows through anterior part of proteronotal shield of cleared specimens. Seta *s*2 present, extremely minute and lying mid-way between a pore and *s*1. Plasmic seta *z*2 bears 5 files of 7 or 8 cilia on distal swollen part.

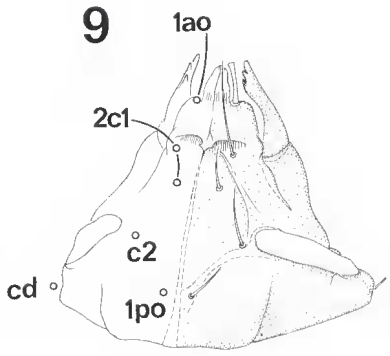
Opisthosternum: Genital and anal shields illustrated (Fig. 7) have lifted away from mid-sternal line, appear narrower. Adanal shields (bearing setal file *Za*) not posteriorly merged together. Transverse ridge on shield between setae *Za*2 and *Za*3. Ovipositors involuted, chaetotaxy difficult to observe. Ovipositor of holotype (contains egg) illustrated (Fig. 10) only 5 pairs of genital setae observed, possibly more present.

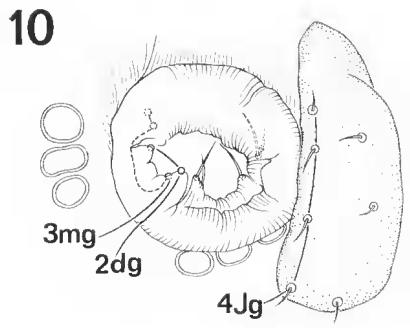


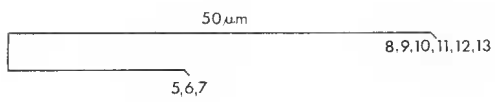


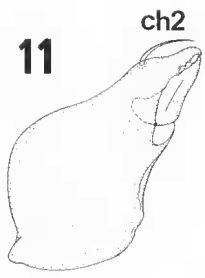


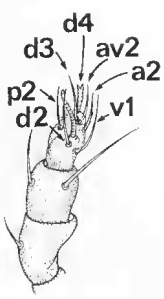


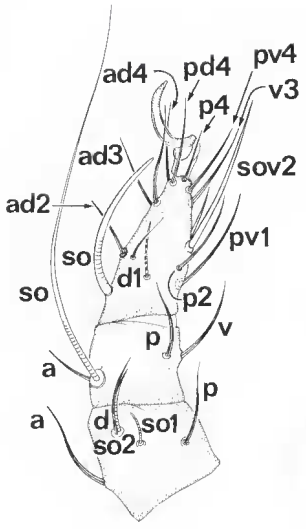


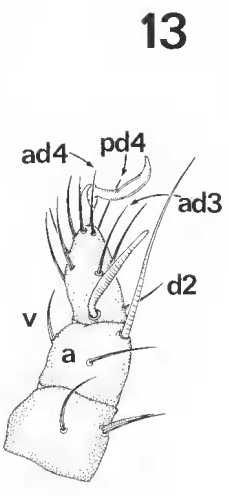


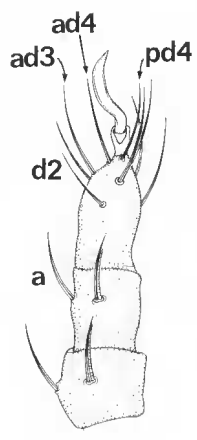


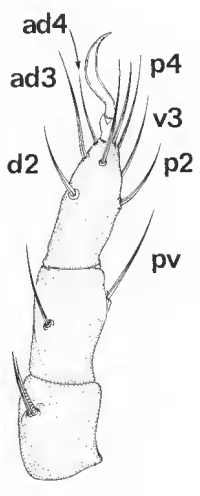












FIGS. 5-13—*Verachthonius moritzi* n.sp., female: 5, notum; 6, pleura; 7, idiosternum; 8, proteronotal cowl; 9, gnathosternum; 10, left genital shield and involuted ovipositor; 11, left chelicera, anterior surface; 12, part left palp, anterior surface; 13, legs, dorsal setae on genua, tibiae and tarsi.

Hysteronotum: Weak ridges on shields appear stronger as illustrated (Fig. 5) than they should be. Outlines of pleural and subnotal shields faint. Seta *S*5 on low tubercle.

Appendages: Chelicerae pale, not refractile, weakly dentate. Setae: *ch* (1), *pa* (0-2-1-3-9), *I* (0-3-3-4-17), *II* (0-4-3-3-14), *III* (2-3-3-3-11), *IV* (1-2-3-4-11). Solenidia: *pa* (0-0-1), *I* (2-1-3), *II* (1-1-1), *III* (1-1-0), *IV* (1-0-0). On tarsus I, only 1 solenidium in normal dorsal position, other 2 solenidia (*sov1* and larger *sov*2) ventral and spiniform. Solenidia on all genua and on tibia III coupled with setae, other dorsal solenidia separate. Absence of solenidium on tibia IV not known on other brachychthoniids.

Somal inclusions: Amongst 20 registered mites, 4 (2 from each site) contain single egg, rest without eggs. Eggs about 80 (70-82.5) long, ellipsoid with uniform smooth surface. Two specimens from Piccaninnie Ponds contain 11 and 18 small (diameter 20-25) spherical objects in hysterosoma which showed no internal structure and became very faint in gum chloral. Possibility that they were spermatophores or cysticercoids of anoplocephalid tapeworms considered and latter, if either, seemed more likely. Six specimens contained 1 or 2 boli, mainly granular, included some rectangular cellular forms.

Male

Unknown

Material examined: Holotype female (N1979315) and 13 paratype females (N1979316-N1979328), litter and sparse grass, under *Acacia sophorae*, coastal scrubland, Piccaninnie Ponds, 20.8.1975, D. C. Lee. Six females (N1979329-N1979334), litter, under *Pinus pinea*, Knott Hill, 22.5.1974, D. C. Lee.

Distribution: South Australia (Aa), South Australia: Piccaninnie Ponds, coastal closed-scrubland, 14 (4/8); Knott Hill, cultivated pine forest, 7 (1/2).

Remarks: Besides having more notal ridges than the other 4 nominal species, *V. moritzi* has conspicously longer notal setae, with seta *J*1 longer than half the distance between *J*1 and *J*2.

The centralward displacement of hysteronotal seta *Z*2 is not conspicuous for a member of the *Liochthonius*-complex, but it is more obvious if viewed at right-angles to the integument in the region of that seta or on squashed specimens.

NEOBRACHYCHTHONIUS-complex

Diagnosis: Brachychthoniidae. Anterior subnotal shield (*SNS*1), bearing seta *S*1, separate from hysteronotal shield. Hysteronotal setae *Z*1, *S*2, *Z*2 and *Z*3 not in nearly straight line parallel to lateral margin of notal shield because seta *Z*2 displaced towards mid-notal line. Subnotal shield *SNS*3 separate or merged with hysteronotal shield. Adoral seta *ao*2 either blunt or stout with swollen distal end. Chaetotaxy of genu III and IV unknown. Coxite IV bearing 3 setae.

Remarks: If the 2 genera included in this genus-complex had not been established, the species would probably be included in *Liochthonius* because of the position of *Z*2. So far they are only known from Europe (Pc). *Paraliochthonius* has to be renamed because its use for a pseudoscorpion genus has priority.

Two genera are included in the *Neobrachychthonius*-complex: *Neobrachychthonius* Moritz, 1976b; *Neoliochthonius* **n.name** for *Paraliochthonius* Moritz, 1976a not *Paraliochthonius* Beier, 1956.

Family TRICHTHONIIDAE n.fam.

Type-genus: *Trichthonius* Hammer, 1961.

Diagnosis: Hypochthonioidea. Minute to medium-sized (155-790), pale mites. Two complete transverse hysteronotal fissures (*TB*2, *TB*3); anterior fissure (*TB*2) never conspicuously closer to seta *J*2 than to *J*3, posterior fissure (*TB*3) about halfway between seta *J*1 and *J*6 or posterior to that level. Anterior part of pleural shield (*PS*1) either partially (less than × 0.6 breadth) separated off by vertical fissure or completely merged with posterior pleural shield (*PS*2). Hysteronotal setae vary considerably in length, setae *J*3 and *Z*3 more than × 2 length of setae *J*2 or *Z*2. Longer setae (*J*3, *J*4, *Z*3, *Z*4) setose with inconspicuous lateral cilia or linguiform with cilia and sometimes fringe of balloon-like structures, at least as long as distance between setal bases *J*1 and *J*4. Hysteronotal seta *S*2 not as near to mid-notal line as *Z*1. Each coxite of legs III and IV completely separate or only separate along mid-sternal line with III and IV merged on each side. No proteronotal eye or eyes in zone between setae *j*1 and *z*1. On tarsus I, seta *d*1 simple, setose or peg-like. Adoral file includes 1 (*ao*2) or 2 (*ao*2, *ao*3) setae.

Remarks: Trichthonius was grouped in the Cosmochthoniidae by Balogh (1972). But, in the classification presented in this paper, *Trichthonius* has to be grouped in the Retrofissurae rather than the Prof-issurae which includes Cosmochthoniidae. If the remarks on the Retrofissurae are studied, it can be seen by characters used there for the diagnosis of superfamiles, that *Trichthonius* must be included in the Hypochthonioidea. Within this superfamily, the Heterochthoniidae is the most suitable to include *Trichthonius*, on the other hand, the presence of a proteronotal eye or eyes in members of the Heterochthoniidae and the forward compression of the large spine-like hysteronotal setae and their shields, has made me reluctantly prefer to establish this new family, the Trichthoniidae.

Three genera are included in Trichthoniidae: *Marshallia* Gordeeva, 1980; *Nipponiella* Gordeeva, 1980; *Trichthonius* Hammer, 1961. *Trichthonius* has been collected in South Australia and is considered below. *Marshallia* includes 2 species: *M. majestus* (Marshall and Reeves, 1970) from North America; *M. golosovae* Gordeeva, 1980 from U.S.S.R. *Nipponiella* includes 1 species: *N. simplex* (Aoki, 1966) from Japan.

TRICHTHONIUS Hammer

Trichthonius Hammer, 1961; 15. Type designation (by monotypy); *"Cosmochthonius pulcherrimus* Hammer".

Type-species: *Trichthonius pulcherrimus* (Hammer, 1958: 22).

Diagnosis: Trichthoniidae. Most notal setae (including *j*2, *J*1, *J*2, *J*3, *J*4,) enlarged, linguiform, ciliate without fringe of balloon-like structures, and able to cover most of notum. Fifth rank of hysteronotal setae (*J*5, *Z*5, *S*5) conspicuously nearer to 6th rank than to zone midway between 4th and 6th ranks. Cheliceral seta *ch*2 conspicuous longer (× 1.2 or more) than fixed cheliceral digit. Two pairs of adoral setae (*ao*2,*ao*3). External malae bifurcate. Each coxite of legs III and IV completely separate. Chaetotaxy of genua: setae *I*-6, *II*-3, *III*-2, *IV*-3; solenidia *I*-1, *II*-1, *III*-1, *IV*-0.

Remarks: The single *Trichthonius* species is superficially very similar to members of the Cosmochthoniidae, especially to *Phyllozetes,* so it is understandable that it has been grouped in that family. Even the gnathosoma is considerably modified (a feature of Cosmochthoniidae), although not in a similar way and there is no conspicuous chitinous structure supporting enlarged pharyngeal muscles. The similarity is mainly due to the enlarged, erectile hysteronotal setae (*J*3, *J*4, *Z*3, *Z*4) which can lie close to the body or spread upwards like a peacock's tail. If the weighting of characters presented here is accepted, the similar characters must be regarded as resulting from convergent evolution. In contrast, *Trichthonius* looks rather different from the much larger, confamilial *Nipponiella,* with its almost simple notal setae and unmodified gnathosoma.

One species is included in *Trichthonius: T. pulcherrimus* (Hammer, 1958).

Trichthonius pulcherrimus (Hammer)

(Figs. 14-21)

Cosmochthonius pulcherrimus Hammer, 1958: 22.

Trichthonius pulcherrimus (Hammer): Hammer, 1961: 15.

Trichthonius pulcherrimus (Hammer): Hammer, 1962: 16.

Female

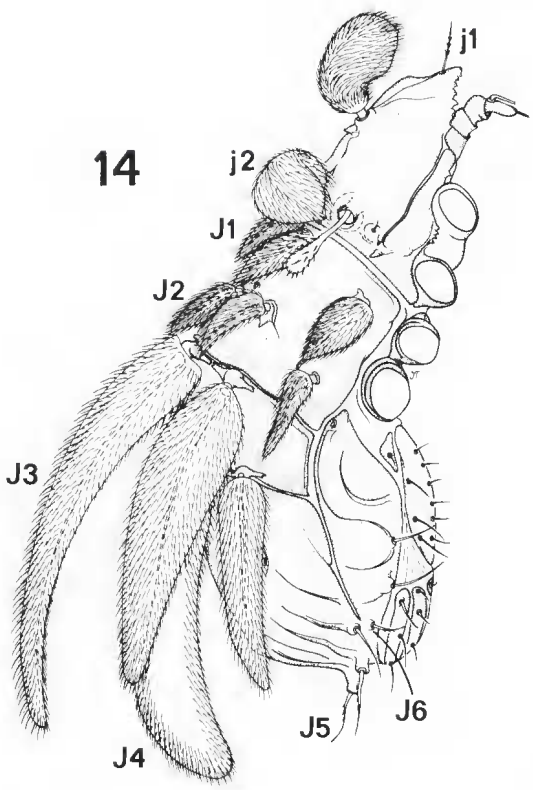
Shields ochre, covered by granulate adhesive layer. Idiosomal length 187.5, (4, 180-190); appendage lengths (for 185)—*ch* 13, *pa* 40, *I* 67.5, *II* 60, *III* 70, *IV* 77.5; tibial breadths—*I* 14, *II* 13, *III* 11, *IV* 13; femur breadths—*I* 14, *II* 13 *III* 14 *IV* 16. Tibial breadths given because trochanter and femur of legs III and IV disproportionately stout compared with rest of leg. Most notal setae subsemicircular in cross-section and possibly hollow with branched struts radiating from ventral midrib to convex dorsal surface. Only dorsal setal surface ciliate, seta *J*4 has dorsal bald patch which seta *J*3 rests on when collapsed down close to body. Erectile setae (*J*3, *J*4, *Z*3, and *Z*4) illustrated (Fig. 14) in intermediate position between lying close to body and being at right-angles to it. Many notal setae on tubercles with large spines. For seta *s*2, spine on tubercle larger than minute seta. Tubercles of 4 pairs of erectile setae carry 2 large, bifurcate spines, apparently articulating with spines of next erectile seta in same rank. Curiously, outward pointing spines of *Z*3 and *Z*4 fit this description although no other spines with which to articulate. Posteriorly, hysteronotal shield has central keel which setae *J*4 rest beside when lowered close to notum. On gnathosoma, adoral setae have rigid curved shaped, seta *ao*2 also has hyaline flap, external malae bifurcate with 2 slim, tapering branches. Chelicerae unusual. Movable digit appears foreshortened with anterolateral groove and large, hooked posterolateral process. Fixed digit edentate, may be movable. Seta *ch*2 large, curved with ventral hyaline flap. chelicerae has groove along anterolateral surface from the region of the mouth to base of movable digit. Pharynx appears simple and without conspicuous muscles supported by chitinous struts. On legs III and IV, trochanter, and to lesser extent femur, large and wrinkled.

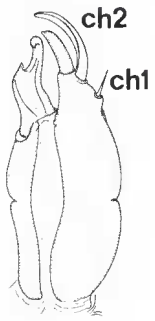
Appendage setae: *ch* (2), *pa* (0-2-1-3-10), *I* (1-3-6-6-19), *II* (0-4-3-5-17), *III* (2-3-2-4-15), *IV* (2-3-3-4-13). Solenidia: *pa* (0-0-1), *I* (1-1-1), *II* (1-1-2), *III* (1-1-0), *IV* (0-1-0). Solenidial form: baculiform on ta*pa*, ta*I*, ti*II*, ta*II*(*so*1 + *so*2); ceratiform on ge*II*, ge*III* ti*III*, ti*IV*; flagelliform with coupled seta on ge*I*, ti*I*.

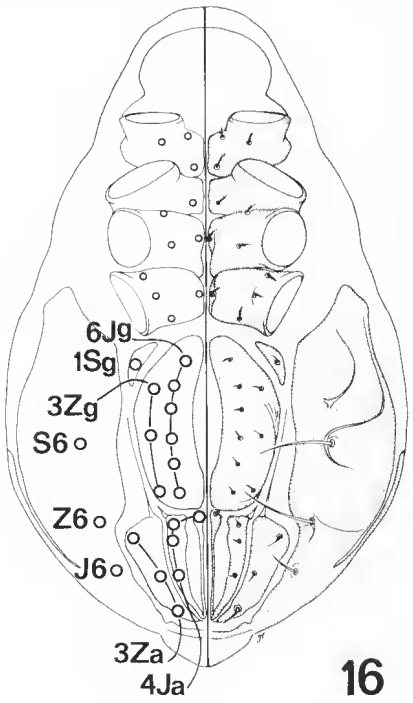
No somal inclusions (food boli or eggs) observed.

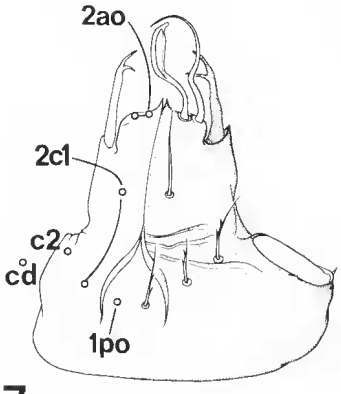
Material examined: One female (N1979335), litter or grass and moss, under *Eucalyptus viminalis,* Chambers Gully, 12.6.1974, D. C. Lee. Three females (N1979336-N1979338), litter and sparse moss, under *Eucalyptus obliqua,* sclerophyll forest, Mt. Lofty, 9.5.1974, D. C. Lee.

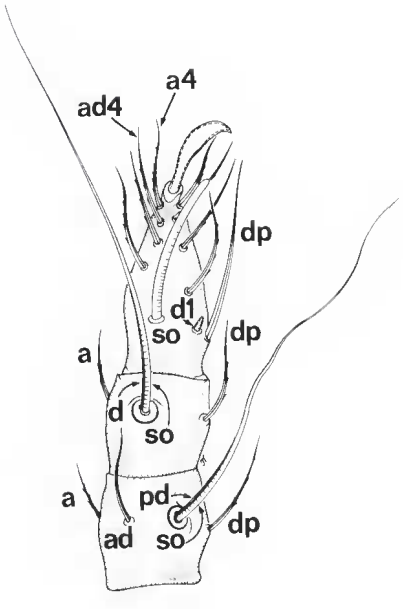
Distribution: Argentina, Bolivia, Chile, Peru (NTe); South Australia (Aa). South Australia: Chambers Gully, savannah woodland, 1(1/8); Mt. Lofty, sclerophyll open-forest, 3(2/8).

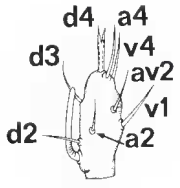


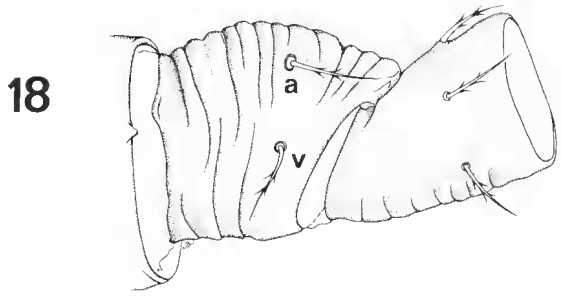


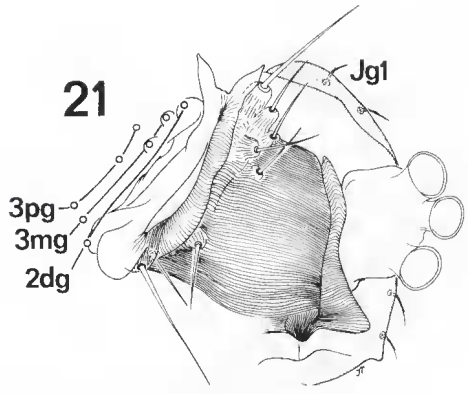


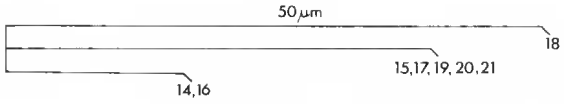












FIGS. 14-21—*Trichthonius pulcherrimus* (Hammer), female: 14, pleura; 15, right chelicera, anterior surface; 16, idiosternum; 17, gnathosternum; 18, left trochanter and femur IV, anterior and ventral surfaces; 19, right leg I, dorsal setae on genu, tibia and tarsus; 20, left palp tarsus, anterior surface; 21, left genital shield and ovipositor.

Remarks: There are differences between the description of the type material and the South Australian specimens, such as larger (230), proteronotal plasmic setz *z*2 not strongly dilated distally, hysteronotal seta *J*4 without dorsal bald patch, tibia I solenidium about half length of genu I solenidium. For the time being, these are regarded as either intraspecific variations or reflecting inaccurate illustration.

The gnathosoma is interesting in having primitive (only present in Bifemoratina and Retrofissurae) disjunct external malae and yet being considerably modified. The adoral setae and external malae appear to be modified to hold a globule of liquid and the chelicerae to provide a tube to suck up liquids. Unfortunately, there were no boli in the 4 specimens collected to give an indication of the nature of the food.

The shape of trochanter III and IV has not been used in the diagnoses of higher taxa. But the simple cylinder (Fig. 18), possibly given more mobility in *T. pulcherrinus* by being wrinkled, could be regarded as primitive, and within the Arthronotina be diagnostic of Retrofissurae. In contrast, *Cosmochthonius* has a modified trochanter (Fig. 24) which must give much more mobility to the leg, and could be diagnostic of Cosmochthonioidea.

Subcohort PROFISSURAE n.

Diagnosis: Arthronotina. Usually 3 transverse hysteronotal fissures (*TB*1, *TB*2, *TB*3), sometimes obscure as when notal setae umbellate (Pterochthoniidae), or when notum folded so that second fissure (*TB*2) covered by first hysteronotal shield (Sphaerochthoniidae), sometimes posterior fissures (*TB*2, *TB*3) partial (some Protoplophoridae), sometimes posterior fissure (*TB*3) absent (Sphaerochthoniidae). No hysteronotal gland with egress pore between setae *Z*4 and *Z*5. Cowl present, enclosing retracted chelicerae. Chelicerae often modified so that either fixed digit or seta *ch*2 comb-like; rarely seta *ch*1 absent in which case *ch*2 simple. Palp tarsus without distal bifurcate plasmic seta and often with 2 ribbon-like dorsal setae conspicuously longer than itself. External malae conjunct. Often conspicuous internal chitinous structure supporting enlarged pharyngeal muscles. One pair (*Zaf*) of adanal pores present. On tarsus I, seta *d*1 never bifurcate. No genua bear solenidia. Pretarsi usually with either 1 claw, 2 unequal claws (1 stout simple claw, 1 slim or ciliate claw) or 3 unequal claws (central stout claw, lateral slim claws), very rarely 2 subequal claws.

Remarks: The Profissurae is a new taxon. It has a diversity of form that reflects that of the Retrofissurae (see remarks on parallel evolution under Arthronotina). The name, Profissurae, is intended to indicate the main attribute which contrasts with Retrofissurae, i.e. that the anterior hysteronotal fissure (*TB*1) is always present.

The comb-like structure of the fixed cheliceral digit has been considered primitive in *Pterochthonius*, suggesting the origin of chelate chelicerae amongst Acari. This is unlikely. Probably, both it, the comb-like seta *ch*2 and other specializations of gnathosoma amongst Profissurae, function by sifting single-celled organisms from liquids. What is peculiar about these attributes is that they occur regularly amongst the Profissurae (whilst being absent elsewhere amongst Cryptostigmata) yet they may be either present or absent in very similar genera. This might lead to the conclusion that there were polymorphic forms or stages of the same species, but there is no support for this concept.

The attributes of pretarsal claws are used in the diagnosis although they are complex. The model is that, amongst Profissurae, pretarsi have a stout central claw, with slim lateral claws 1 or both of which may be lost especially on anterior legs, so that there should not be 2 subequal claws as on some other Arthronotina. The 1 known exception is *Cosmochthonius bengalensis* with 2 equally thick and curved claws on all pretarsi. The form of the claws of *Krivolutskiella* (Cosmochthoniidae) is not known, although they are unusual for the Profissurae in there being 2 claws on pretarsus IV.

The Profissurae includes 2 superfamilies: Cosmochthonioidea Grandjean, 1969; Protoplophoroidea Grandjean, 1965. The Protoplophoroidea includes 1 family as listed by Balogh (1972) and in relation to this study has been referred to (Lee 1981) under the now disbanded Arthroptyctima. The Cosmochthonioidea, some of which were also collected in this study, are considered further below.

Superfamily COSMOCHTHONIOIDEA

Diagnosis: Profissurae. Prehysteronotal fissure usually not hinged and never acutely hinged.

Remarks: The genera of Cosmochthonioidea as delineated here are very much as listed by Balogh (1972), except that the Pterochthoniidae are included. Grandjean (1954b: 334) drew attention to the remarkable similarity between members of this superfamily, particularly *Sphaerochthonius*, and the Protoplophoridae. In fact, whilst the Protoplophoridae was given quite a substantial diagnosis in my previous paper (Lee 1981: 212), if it was diagnosed here as a superfamily to be delineated from the Cosmochthonioidea, I would be confident only of giving its acutely hinged prehysteronotal fissure as a diagnostic attribute. Mahunka (1977b) established a new protoplophorid genus, *Hauseroplophora* from Kenya, which, because of its superficial similarity to *Sphaerochthonius*, he regarded as further supporting Grandjean's supposition. But in fact, although the form of its setae is similar to *Sphaerochthonius*, *Hauseroplophora* is not as similar as *Aedoplophora* and *Cryptoplophora*

(2 other genera of Protoplophoridae) are to *Sphaerochthonius* in the shape and disposition of the somal shields. Certainly, further study of established taxa within the Profissurae may indicate a broader basis for distinguishing the Protoplophoroidea from this superfamily. For example, *Sphaerochthonius* appears to share with *Cosmochthonius* the proximal construction of femur and trochanter IV, whilst these segments on members of the Protoplophoroidea are without such a constriction. On the other hand, a more thorough examination of *Sphaerochthonius* may indicate that it can, or originates from mites that could, fold up its soma around hinged fissures. This or other attributes may make the superfamily groups here redundant. Possibly, the present diverse Protophophoroidea represents a convergence from different evolutionary trends within the Cosmochthonioidea, but at this stage, I am adopting a conservative approach and maintaining it as in the classification of Balogh (1972).

The Cosmochthonioidea includes 4 families: Cosmochthoniidae Grandjean, 1946; Haplochthoniidae van der Hammen, 1959; Pterochthoniidae Grandjean, 1950b; Sphaerochthoniidae Grandjean, 1947a. The Haplochthoniidae and Pterochthoniidae were not represented in collections for this study and are not further considered.

Family COSMOCHTHONIIDAE Grandjean

Cosmochthoniidae Grandjean, 1946: 315.

Type-genus: *Cosmochthonius* Berlese, 1910.

Diagnosis: Cosmochthonioidea. Minute (240-360), ivory white to brown mites. Three complete, unobscured hysteronotal fissures (*TB*1, *TB*2, *TB*3). Four pairs of hysteronotal setae (*J*3, *J*4, *Z*3, *Z*4) long (at least as long as distance between setal bases *J*1 and *J*4) and erectile. Cowl broken up by 2 to 4 ranks of 4-9 longitudinal slits. Anterior subpleural shield (*SPS*1) has protruding ventral wing-like process, whilst subpleural shield (*SPS*2) has ventral extension to large pore. Genital tracheae present. Anterior cheliceral seta (*ch*2) pectinate with, 5 or 6 prongs. Tarsus I bears 1 solenidium. Tarsi I-IV with 2 or 3 claws.

Remarks: This widespread family, the Cosmochthoniidae, has very similar members grouped in 3 genera: *Cosmochthonius* Berlese, 1910; *Krivolutskiella* Gordeeva, 1980; *Phyllozetes* Gordeeva, 1978. Both *Cosmochthonius* and *Phyllozetes* have been collected in South Australia and are considered below. *Krivolutskiella* includes 1 species: *K. pubescens* Gordeeva, 1980 from the Canary Islands.

COSMOCHTHONIUS Berlese

Cosmochthonius Berlese, 1910a: 221. Type designation (original): "*C. lanatus* (Mich.)".

Type-species: *Cosmochthonius lanatus* (Michael, 1885: 396).

Diagnosis: Cosmochthoniidae. Some notal setae (*J*3, *J*4, *Z*3, *Z*4) long, stout, ciliate without broad leaf-like lateral membrane. Pretarsus I with 2 claws, pretarsi II, III and IV with 2 or 3 claws (2 subequal claws or stout central claw with 1 or 2 slim lateral claws). Coxites III and IV separate from each other. More setae on femur II and tarsi III and IV (6, 16 and 14).

Distribution: Widespread—Canada (Nn), California (Nc), Nevada (Nr); Bolivia, Argentina, Peru (NTc); Ghana (Ew); England, Germany, France, Russia (Pe); Italy (Pm); Russia (Ps); East Java (Om); Australia (Aa), New Zealand (An).

Remarks: Cosmochthonius is an easily recognised genus, but 2 species originally grouped in it are now combined in other genera. One, *Trichthonius pulcherrimus* (Hammer), see above, is here regarded as only superficially similiar, and is now in another subcohort (Retrofissurae). The other, *Phyllozetes emmae* (Berlese), see below, is similiar but was excluded by a restriction in the extent of the genus. The value of restricting the genus is questionable since the discovery of taxa with 2 claws on all legs: *Krivolutskiella* with some leaf-like hysteronotal setae (*J*3, *Z*3) like those of *Phyllozetes*; *Cosmochthonius bengalensis* with hysteronotal setae characteristic of *Cosmochthonius.*

Most descriptions of *Cosmochthonius* species are almost confined to the notal surface: exceptions are those of *C. reticulatus* by Grandjean (1962) and *C. fovealatus* as originally described. Having given new status to 3 subspecies, revoked a synonymy and named a previously described but unnamed species there are now listed below 15 species of *Cosmochthonius*. Gordeeva (1980) provides a key for 7 palaearctic species, which still leaves a problem for those wishing to identify *Cosmochthonius* from elsewhere. Since, in the past, notal sculpturing and the ciliation of the 4 large erectile setae (*J*3, *J*4, *Z*3, *Z*4) are the main diagnostic characters, I have used a unified terminology (see above under "Notation for Morphology") to briefly describe such attributes for all species. Some characters that differ from *C. australicus* (as described below) are also referred to. For convenience, the species are grouped in 4 species-complexes: *reticulatus*-complex, *foveolatus*-complex, *plumatus*-complex, *asiaticus*-complex.

reticulatus-complex

Diagnosis: Reticulate sculpturing covering posterior hysteronotal shield (*NS*4). Cilia on hysteronotal seta *J*3 even, usually short and sparse, rarely longer or medium spaced, between 14-38 on 1 side.

Remarks: Five species are included in the *reticulatus*-complex. The inclusion of *C. lanatus* is debatable.

Cosmochthonius bengalensis Chakrabarti *et al.*

Cosmochthonius bengalensis Chakrabarti, Bhaduri and Raychaudhuri, 1972: 86.

Length, 288-290 (ex West Bengal—Oi). Seta *z*1 unbranched. Seta *s*2 long, ciliate as *j*1. Seta *J*2 not on anterior ridge of second hysteronotal shield (*NS*2). Seta *J*3 with about 36 short sparse cilia on each side. Coxites I, II, III, IV with 3, 1, 3, 3 setae. Pretarsi I, II, III, IV with 2, 2, 2, 2 equally thick claws.

Cosmochthonius lanatus (Michael)

Hypochthonius lanatus Michael, 1885: 396.
Hypochthonius lanatus Michael, 1888: 541.
Cosmochthonius lanatus: Willmann, 1931: 101.

Length, 330 (ex England—Pe), 290-320 (ex Germany—Pe). Seta *z*1 unbranched. Seta *J*3 with more than 25 medium lengthed and medium spaced cilia on each side.

Remarks: Michael (1888) illustrates *C. lanatus* with large abutting puncta on the notum, but in the text states "notogaster is strongly and coarsely reticulated", also Willmann's (1931) illustration shows dorsal pits with distinctly straight edges. On the other hand, in Gordeeva's (1980) key (couplet 9/10), for *"Cosmochthonius* sp. *(lanatus?)"* the notal surface is described as having rounded abutting pits, and van der Hammen (1952) regards *C. domesticus* as synonymous with *C. lanatus*. Therefore the position of this poorly described species is uncertain.

Cosmochthonius reticulatus Grandjean

Cosmochthonius reticulatus Grandjean, 1947b: 354.
Cosmochthonius reticulatus Grandjean, 1962: 404.

Length, 300-340 (ex France—Pe). Cheliceral fixed digit with 5 well developed teeth, seta *ch*2 with 6 prongs. Transverse ridge between setal pair *j*1. Seta *s*2 long, ciliate (compared with *C. australicus)* although shorter and slimmer than other proteronotal setae. Plasmic seta *z*2 with distal half much stouter (× 6) than proximal half. Seta *J*2 not on anterior ridge of second hysteronotal shield (*NS*2). Seta *J*3 with 14 long sparse cilia on each side. Appendage setae and solenidia similar to *C. australicus* except tibia III with 5 and tarsus III with 15 setae.

Cosmochthonius sublanatus Mahunka

Cosmochthonius sublanatus Mahunka, 1977a: 254.

Length, 273-294 (ex eastern Java—Om). Seta *z*1 unbranched. Seta *s*2 long, ciliate as *j*2. Seta *j*3 with about 30 short medium spaced cilia on each side. Seta *z*3 with sparse cilia, *J*4 and *Z*4 shorter (× 0.5) than 3rd setal rank.

Cosmochthonius wallworki n.sp.

Cosmochthonius spec. *(C. lanatus?)* Wallwork, 1960: 386.

Length, 291 (ex Ghana—Ew). Seta *s*2 long, ciliate (compared with *C. australicus)* although shorter than other proteronotal setae. Plasmic seta *z*2 with distal half slightly stouter (× 1.5) than proximal half. Seta *J*2 on anterior ridge of second hysteronotal shield (*NS*2). Seta *J*3 with 18 short sparse cilia on each side.

***foveolatus*-complex**

Diagnosis: Punctate sculpturing covering posterior hysteronotal shield (*NS*4). Cilia on hysteronotal seta *J*3 even, long and either sparse or dense, between 5-60 on 1 side.

Remarks: Six species are included in the *foveolatus*-complex. Three species *(C. domesticus, C. foveolatus, semiareolatus)* are similar to each other in having denser cilia and closer spaced puncta, and have been referred to as similar to *C. lanatus (reticulatus*-complex).

Cosmochthonius domesticus Grandjean

Cosmochthonius domesticus Grandjean, 1947b: 354.

Length, 245-285 (ex France—Pe). Cheliceral fixed digit with 4 teeth, central 2 inconspicuous, seta *ch*2 with 6 prongs. Form of cilia on hysteronotal seta *J*3 unknown. Puncta on posterior hysteronotal shield (*NS*4) large, circular or oval, never polygonal, and abutting.

Remarks: The synonomy of *C. domesticus* with *C. lanatus* (van der Hammen, 1952: 22) is revoked on the basis that it is not yet satisfactorily established.

Cosmochthonius foveolatus Beck n. status

Cosmochthonius lanatus foveolatus Beek, 1962: 232.

Length, 320-360 (ex Peru—NTc). Cheliceral fixed digit with 4 conspicuous teeth, seta *ch*2 with 5 prongs. Seta *z*1 unbranched. Ridge and tubercles connecting posterior margin of bothridia of plasmic setae *z*2. Seta *J*2 not on anterior ridge of second hysteronotal shield (*NS*2). Seta *J*3 with about 35 long, dense cilia on each side. Puncta on posterior hysteronotal shield (*NS*4) large, circular and abutting.

Cosmochthonius ponticus Gordeeva

Cosmochthonius ponticus Gordeeva, 1980: 844.

Length, 245 (ex Crimea—Pe). Seta *s*2 long, ciliate

(compared with *C. australicus)* although shorter than other proteronotal setae. Seta *J*3 with 5 or 6 medium lengthed cilia on each side near base. Puncta on posterior hysteronotal shield (*NS*4) large, irregular in outline and well separated.

Cosmochthonius semiareolatus Hammer

Cosmochthonius semiareolatus Hammer, 1966: 14.

Length, 285 (New Zealand—An). Seta *s*2 long, ciliate as *j*2. Seta *J*3 with about 60 long (longest in genus), dense cilia on each side. Puncta on posterior hysteronotal shield (*NS*4) large, circular and abutting.

Cosmochthonius tenuisetus Gordeeva

Cosmochthonius tenuisetus Gordeeva, 1980: 844.

Length, 245 (ex Crimea—Pe). Seta *s*2 long, ciliate (compared with *C. australicus)* although shorter than other proteronotal setae. Seta *J*2 long (reaches back to setal base *J*4). Seta *J*3 with 6 or 7 long, sparse cilia on each side, evenly spaced along seta. Puncta on posterior hysteronotal shield (*NS*4) small, circular and well separated.

Cosmochthonius ugamaensis Gordeeva

Cosmochthonius ugamaensis Gordeeva, 1980: 846.

Length, 290 (ex Uzbekistan—Ps). Seta *j*1 bifurcate, Y-shaped. Seta *s*2 long, ciliate as *j*2. Seta *J*2 not on anterior ridge of second hysteronotal shield *(NS*2). Seta *J*3 with 6 long, sparse cilia on each side, evenly spaced along seta. Puncta on posterior hysteronotal shield *(NS4)* large, star-shaped in outline and close although not abutting.

***plumatus*-complex**

Diagnosis: Punctate sculpturing covering posterior hysteronotal shield *(NS*4). Cilia on hysteronotal seta *J*3 uneven with both sparse long cilia and dense short (3 or 4 to each long cilium) cilia.

Remarks: Two species are included in the *plumatus*-complex, 1 of which is *C. australicus* collected in this study.

Cosmochthonius australicus Womersley n.stat.

(Figs. 22-29)

Cosmochthonius plumatus australicus Womersley, 1945: 222.

Female

Dull, ochre to orange. Cuticle covered in granulate hyaline adhesive layer which easily peels off. Refractile parts (external malae, cheliceral extremities, setae and claws) paler than general integument. Idiosomal length 280 (20 ex Ferries-McDonald, 275-285: others within this range); appendage lengths (for 280)—*ch* 15, *pa* 60, *I* 120, *II* 95, *III* 100, *IV* 115; femur breadths—*pa* 14, *I* 24, *II* 22.5, *III* 20, *IV* 20.

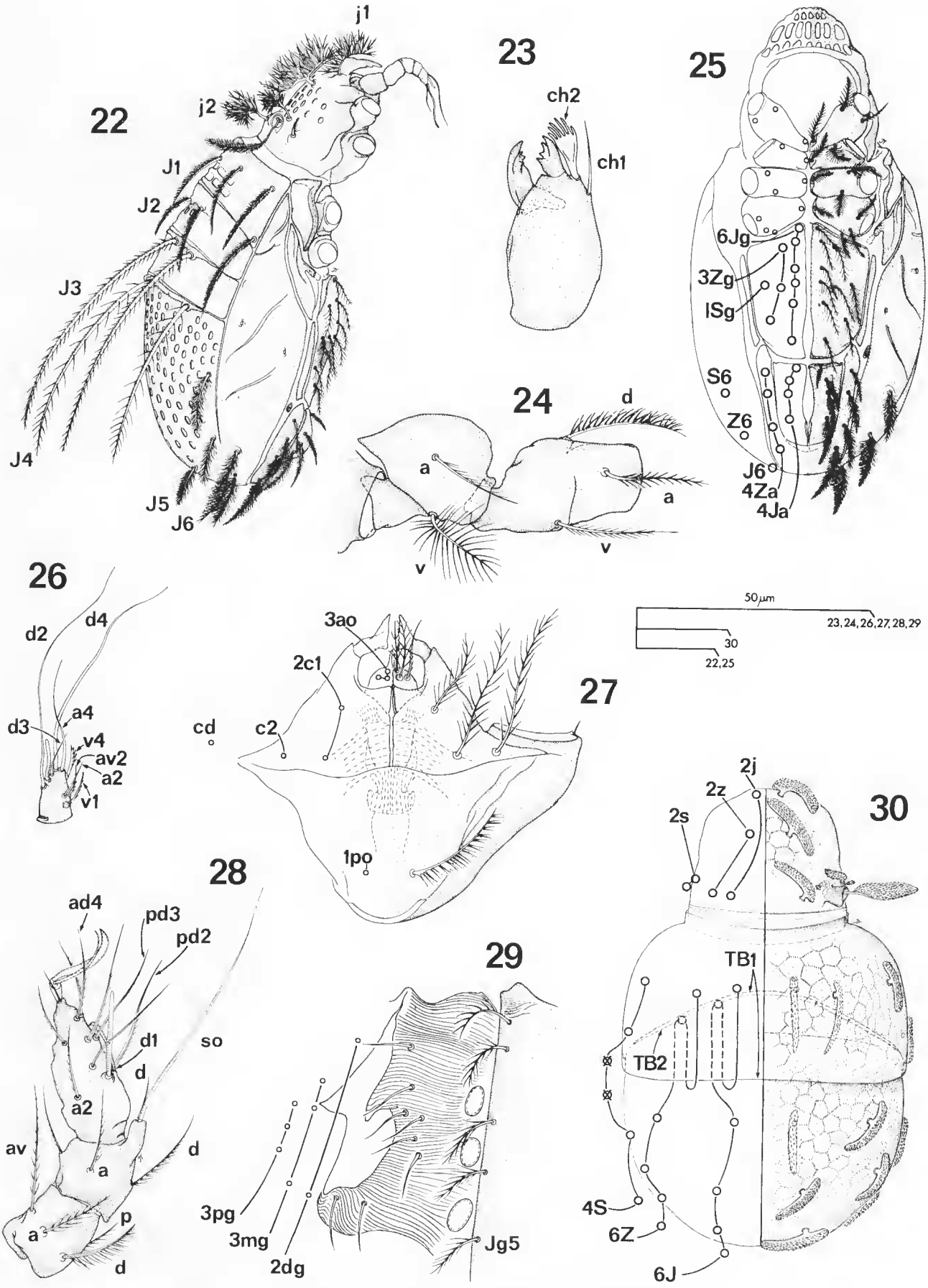
Puncta on posterior hysteronotal shield *(NS*4) large, circular and close although not abutting. On next shield *(NS*3), few very faint puncta not represented in illustration (Fig. 22). Few distinct puncta on second shield *(NS*2). On anterior shield *(NS*1), few rectangular pits. Setae *J*3, *Z*3, with about 24 long cilia and about 100 short cilia on each side. Setae *J*4, *Z*4 shorter with longer sparser long cilia. Proteronotal seta *z*1 bifurcate and T-shaped, with shorter posterior branch.

Cowl sometimes has 3 ranks of slits, posterior rank with 9 slits, middle rank with 7 slits, anterior rank with 5 slits, but arrangement may be more haphazard. Bases of conjunct external malae with central triangular flaps covering bases of internal malae and, with external malae, encompass oval aperture through which preoral setae protrude. Mentum undelincated, transverse ridge not regarded as mentocoxal fissure. Three wing-like processes on pleural and subpleural shields, lying above coxae III and IV. Posterior subpleural shield *(SPS*2) with ventral extension that becomes groove, lined with processes or hairs, leading to conspicuous pore behind coxa IV.

Chelicerae pale, fixed digit with 4 well developed refractile teeth. Trochanter IV and femur IV, to lesser extent same segments on leg III, unusual for primitive oribatids (possibly true for all Cosmochthonioidea) in being constricted proximally. These segments look as if they may be able to rotate around their proximal articulation, rather than rock backwards and forwards.

Appendage setae: *ch* (2), *pa* (0-2-1-3-11), *I* (0-5-5-6-19), *II* (1-6-5-6-17), *III* (2-3-4-4-14). Solenidia: *pa* (0-0-1), *I* (0-0-1), *II* (0-1-1), *III* (0-1-0), *IV* (0-1-0). Claws: I-2; II, III, IV-3. Cheliceral seta *ch* 2 with 6 prongs. Some setae on palp tarsus long and at least seta *d*4 ribbon-like and possibly plasmic. On tarsus I, plasmic seta *d*1 dilates slightly distally, curling around seta *pd*3. On tibia I, solenidium and coupled seta on conspicuous tubercle. Solenidia on posterior 3 pairs of legs ceratiform, those on tibiae (especially tibia IV) small. Positor short, but too large to be male, although all genital setae appear similar in size.

Conspicuous internal chitinous structures encompass pharynx between level of preoral and postoral setae, also ovoid refractile membrane (not illustrated) arises in region of palp coxite and extends backwards to coxite II, probably equivalent of "*vpx*" (Grandjean 1948: fig. 3A). Genital tracheae extend forward from anterior end of genital orifice. Gut contents consist entirely of dark green granular material and refractile spheres (diameter, 2-3). Narrow pharynx expands about level of seta *J*2 into fat horseshoe-shaped pair of dorsal diverticulae that loop backwards around



FIGS. 22-30—Cosmochthonioidea: 22-29, *Cosmochthonius australicus* Womersley, female; 22, pleura; 23, right chelicera, anterior surface; 24, left trochanter and femur IV, anterior and ventral surfaces; 25, idiosternum; 26, left palp tarsus, anterior surface; 27, gnathosternum; 28, right leg I; 29, left genital shield and ovipositor; 30, *Sphaerochthonius splendidus* (Berlese), notum.

lateral margins of hysteronotum. Dorsal diverticulae often uniformly full of food. At anterior end of horse-shoe-shape (between level of setae *J2* and *J3*) gut inclines ventralwards to anus. This strip of straight gut usually contains 2 or 3 boli, anterior bolus being diffuse and larger whilst posterior bolus smaller (diameter, about 25) and dense. No eggs observed inside mites.

Material examined: Lectotype (N1979378) and 2 paralectotypes (N1979379-N1979380), moss, Mt. Arden, southern Flinders Ranges, 11.1943, H.M. Cooper. Twenty females (N1979339-N1979358), litter and sparse moss, under *Eucalyptus incrassata*, mallee scrubland, Ferries-McDonald, 20.6.1974, D.C. Lee. Six females (N1979359-N1979364), grass and moss or litter under *Eucalyptus viminalis*, savannah woodland, Chambers Gully, 12.6.1974, D.C. Lee. Twelve females (N1979365-N1979376), litter and sparse moss, under *Eucalyptus obliqua*, sclerophyll forest, Mt. Lofty, 9.5.1974, D.C. Lee. One female (posterior half) (N1979377), grass and plantain, Glenthorne, 12.6.1974, D.C. Lee.

Distribution: South Australia (Aa). South Australia: Ferries-McDonald, mallee-broombush open-scrubland, 20(3/8); Chambers Gully, savannah woodland, 6(3/8); Mt. Lofty, sclerophyll open-forest, 12(4/8); Glenthorne, cultivated pasture, 1(1/8); Mt. Arden and Waterfall Gully (Womersley, 1945).

Remarks: Regarding the collection data, the record of 1 specimen from Glenthorne is based on a hysterosoma alone, but from its condition it is assumed that the mite was damaged after collection. The original 6 specimens from Waterfall Gully cannot be found. Instead of the 2 specimens, as originally recorded from Mt. Arden, there are 3 specimens with exactly the same labels. The specimen designated as the lectotype is the specimen drawn (Womersley, 1945: fig. 2) on the basis of the position of hysteronotal setae. One specimen designated as a paralectotype cannot belong to the published syntype series, but, since it is not known which one, this has to be disregarded.

The original description (Womersley, 1945) is inaccurate for a number of attributes, for example the form of the cilia on hysteronotal setae *J3*, *J4*, *Z3*, *Z4* and the presence of punctuations on the third hysteronotal segment (*NS*3). Since these inaccuracies apply to the main 2 groups of characters used in diagnosis, it highlights the need for this genus to be reviewed by someone with type specimens before him rather than only descriptions in the literature.

Cosmochthonius australicus can be distinguished from *C. plumatus*, the only other member of the species-complex, by the form of the hysteronotal puncta. On the other hand, these puncta are similar to those of some members of the *foveolatus*-complex which also have seta *J3* with even, dense, long cilia.

The gnathosoma of this species, as that of a number of other members of the Profissurae, is unusual, as initially described by Grandjean (1948 and 1954b). The ribbon-like palp setae and the comb-like cheliceral seta suggest that the food is swept out of a liquid, possibly with the slits in the cowl also acting as a sieve. Whilst the structures at the anterior end of the pharynx may be a crushing or suctorial mechanism. On the other hand, although in South Australia *C. australicus* is recorded from moister regions, mallee scrubland is not an environment in which free water is often present.

Cosmochthonius plumatus Berlese

Cosmochthonius plumatus Berlese, 1910: 221.
Cosmochthonius plumatus: Grandjean, 1950a: 78.

Length, 300 (ex Italy—Pm). Cheliceral fixed digit with 4 well developed teeth, seta *ch*2 with 6 prongs. Seta *s2* with long cilia. Seta *J3* form only partially known, but cilia uneven with sparse long cilia and dense short cilia. Puncta on posterior hysteronotal shield (*NS*4) small, varying in size and well separated.

asiaticus-complex

Diagnosis: No sculpturing covering posterior hysteronotal shield (*NS*4). Cilia on hysteronotal seta *J3* even, long and sparse, between 8-22 on 1 side.

Remarks: Two species are included in the *asiaticus*-complex. One species (*C. suramericanus*), because it apparently has only 1 claw on each of its pretarsi, may be based on a nymph.

Cosmochthonius asiaticus Gordeeva

Cosmochthonius asiaticus Gordeeva, 1980: 846.

Length, 319 (ex Tadzhikstan—Ps). Seta *s2* long, ciliate as *j2*. Seta *J2* long (reaches back almost to setal base *J4*). Seta *J3* with 8 long, sparse cilia on each side, evenly spaced along seta.

Cosmochthonius suramericanus Hammer n.stat.

Cosmochthonius plumatus suramericanus Hammer, 1958: 23.

Length, 220 (ex Argentina—NTc). Seta *s2* long, ciliate as *j2*. Seta *J3* with about 25 long, sparse cilia on each side.

PHYLLOZETES Gordeeva

Phyllozetes Gordeeva, 1978: 1099. Type designation (original): "*Cosmochthonius emmae* Berl., 1910".

Type-species: *Phyllozetes emmae* (Berlese, 1910: 222).

Diagnosis: Cosmochthoniidae. Some notal setae (*J3*, *J4*, *Z3*, *Z4*) long, stout, leaf-like with broad lateral membrane bearing marginal cilia. Pretarsi I, II and III with 2 claws (stout central claw, slim anterior claw), pretarsus IV with 3 claws. Coxites III and IV merged together. Fewer setae on femur II and tarsi III and IV (5, 13 and 12).

Distribution: Widespread—Texas (Nr); France, east Crimea (Pe); Algeria, Austria, Greece, Hungary, Italy (Pm); Japan (Pc); India (Oi); Komodo Islands (Am); South Australia (Aa).

Some literature suggests that species are found in humus amongst trees or in moist ground even if poor in organic material. But *Phyllozetes* is also recorded from rapid draining sandy soil with depleted vegetation. In South Australia it was collected in a fairly dry sandy area, as well as from moister sites, 1 having a substantial humus layer.

Remarks: Phyllozetes is certainly closely allied to *Cosmochthonius* and *Krivolutskiella*. It may in the future prove preferable to group these genera together.

The name *"Ovochthonius"* is used in combination with *P. emmae* by Mahunka (1980: 110) with the authority of Gordeeva 1978: 1099. This is presumed to result from confused communication, since *Ovochthonius* Ryabinin in Ryabinin and Krivolutzky, 1977 is grouped in the Heterochthoniidae.

Five species are included in *Phyllozetes: P. emmae* (Berlese, 1910); *P. hypoquercus* McDaniel and Bolen, 1980; *P. latifolius* Gordeeva, 1980; *P. osithchnjukovi* Gordeeva, 1980; *P. tauricus* Gordeeva, 1978.

The specimens collected in this study are grouped in *P. emmae*. Because it is difficult to delineate this species, the other 4 species are briefly described. *P. hypoquercus:* length, 285 (ex Texas—Nr); seta *j*1 Y-shaped; setae *J2-J2* close (× 0.5 *J2-Z2*); setae *J3*, *Z3* similar to *J4*, *Z4*, with short, dense marginal cilia (over 50 on 1 side), coxites I, II, III, IV with 3, 3, 3, 3 setae. *P. latifolius:* length, 150 (ex Canary Islands—Pm, Crimea—Pe); seta *j*1 unbranched; setae *J2-J2* close (× 0.5 *J2-Z2*); setae *J3*, *Z3* narrower, with short, medium spaced marginal cilia (about 32 on 1 side); setae *J4*, *Z4* broader, with long, medium spaced marginal cilia (about 32 on 1 side); number of setae on coxites unknown. *P. osithchnjukovi:* length, 160 (ex Russia—Pe); seta *j*1 unbranched, setae *J2-J2* with bases touching (less than × 0.1 *J2-Z2*); setae *J3*, *Z3* narrower, with short, dense marginal cilia (about 55 on 1 side); setae *J4*, *Z4* broader, with medium lengthed and long, medium spaced marginal cilia (about 35 on 1 side); number of setae on coxites unknown. *P. tauricus:* length, 285 (ex Crimea—Pe); seta *j*1 Y-shaped, seta *J2-J2* widely spaced (× 0.8 or more *J2-Z2*); setae *J3*, *Z3* narrower, with long sparse marginal cilia (about 15 on 1 side); *J4*, *Z4* broader, with long, sparse marginal cilia (about 17 on 1 side), coxites I, II, III, IV with 3, 3, 3, 3 setae.

Phyllozetes emmae (Berlese)

(Fig. none)

Cosmochthonius emmae Berlese, 1910: 222.
Cosmochthonius emmae Berlese: Mahunka, 1977: 254.
Ovochthonius emmae (Berlese): Mahunka, 1980: 110.
Phyllozetes emmae (Berlese): Gordeeva, 1980: 849.

Female

Ivory-white to pale straw-coloured. Cuticle covered by dirty, hyaline, adhesive exudate. Idiosomal length 200 (4, 187.5-210); appendage lengths (for 187.5 ex Piccaninnie Ponds)—*ch* 11, *pa* 40, *I* 72.5, *II* 57.5, *III* 60, *IV* 72.5; femur breadths—*pa* 10, *I* 19, *II* 18, *III* 15, *IV* 15.

Hysteronotal shields appear to lack sculpturing. Proteronotal seta *j*1 bifurcate (Y-shaped), seta *z*1 bifurcate (T-shaped) with posterior branch about X0.5 length of anterior branch. Hysteronotal setal pair *J2* almost (X0.8 or more) as far apart as distance between setal bases *J2-Z2*. Anterior erectile setae (*J3*, *Z3*) with lateral lamellae gradually tapering, and long, dense to medium spaced cilia along margin (about 30 on 1 side). Posterior erectile setae (*J4*, *Z4*) with broader gradually tapering lateral lamellae, and long, dense to medium spaced cilia along margin (32-35 on 1 side). Shape of most other somal setae similar to that of *P. tauricus*. Coxites I, II, III, IV with 3, 2, 3, 4 setae. Central margin of genital shield with 6 *Jg* setae. Chaetotaxy and solenidiotaxy of appendages similar to *C. australicus*, except femur II has only 5 setae (seta *a* absent), tarsus III has only 13 setae (setae *p*2, *pv*2, *v*3 absent), tarsus IV has only 12 setae (setae *pv*2, *v*3 absent). Claws: I, II, III-2; IV-3.

Gnathosoma, internal structures around pharynx, genital tracheae, structure of alimentary canal and contained food, ovipositor, all similar to those of *C. australicus*.

Material examined: Two females (N1979383 and N1979384), litter and sparse moss, under *Eucalyptus incrassata*, mallee scrubland, Ferries-McDonald, 20.6.1974, D. C. Lee. One female (N1979382), litter, under *Banksia ornata*, mallee-heath shrubland, Tamboore, 4.7.1974, D. C. Lee. One female (N1979381), litter and sparse grass, under *Acacia sophorae*, coastal scrubland, Piccaninnie Ponds, 20.8.1975, D. C. Lee.

Distribution: Uncertain because of difficulty of identification. Possibly Palaearctic and Australian regions. South Australia: Ferries-McDonald, mallee-broombush open-scrubland, 2 (1/8); Tamboore, mallee-heath tall open-shrubland, 1 (1/8); Piccaninnie Ponds, coastal closed-scrubland, 1 (1/8).

Remarks: Specimens regarded as *P. emmae* are described from 3 localities other than the type material and that from South Australia. These descriptions are almost limited to 2 erectile hysteronotal setae (*J*3 and/or *J*4) and they show considerable variation. On the original illustration of the type (Berlese 1910: fig. 49) from Italy (Pm), the erectile hysteronotal setae have marginal cilia which are so short and dense they are hardly discernable. On the other hand Mahunka's (1980: figs. 11, 12) illustrations of these setae shows the marginal cilia as long and medium-spaced to sparse (22-27 on 1 side) with seta *J*4 slightly bigger but similar to *J*3. Mahunka's (1977: fig. 9) illustration of *J*3 or *J*4 on a specimen from Vienna (Pe) is similar to this latter description of the type. Seta *J*3 or *J*4 on a specimen from Komodo Island (Am) (Mahunka 1977: fig. 8) has short dense marginal cilia (about 56 on 1 side) and is almost parallel sided with an acutely tapering tip, therefore, it is excluded from *P. emmae*. Specimens from the Crimea (Pe) (Gordeeva 1980: figs. 5, 6) have short medium spaced marginal cilia (29-31 on 1 side) and should possibly also be excluded from *P. emmae*.

In identifying the South Australian specimens, Mahunka's (1980) redescription of the type is accepted, and the fact that there are more and denser marginal cilia on setae *J*3 and *J*4 is regarded as an intraspecific variation. A more comprehensive redescription of the type may require that a new species be established for this material.

Family SPHAEROCHTHONIIDAE Grandjean

Sphaerochthoniidae Grandjean, 1947a: 224.

Type-genus: *Sphaerochthonius* Berlese, 1910

Diagnosis: Cosmochthonioidea. Minute (237.5-375), whitish to brown mites. One complete hinged hysteronotal fissure (*TB*1) present; second hysteronotal fissure (*TB*2) just posterior to seta *J*2, but obscured by anterior hysteronotal shield (*NS*1); 3rd hysteronotal fissure (*TB*3) present on larva or some nymphs in region of seta *J*3, rarely represented on adult, although sometimes transverse dorsal ridges near setae *J*3 and *J*4. No hysteronotal setae erectile or long (not as long as distance between setal bases *J1* and *J*4) and, except setae *J*2 and *Z*2, all ciliate and seta *Z*1 T-shaped. Setae *J*2 and *Z*2 simple, shorter than distance between setal bases *J*2-*J*2, and normally under anterior hysteronotal shield. Cowl without longitudinal slits. Anterior cheliceral seta (*ch*2) pectinate with 3 prongs. Tarsus I bearing 3 solenidia. Tarsi I-IV with 3 claws.

Remarks: Despite the superficial lack of similarity between the Sphaerochthoniidae and the Cosmochthoniidae, they have usually been regarded as closely allied. Also (see above in the remarks on the Cosmochthonioidea) Sphaerochthoniidae has long been regarded as allied to the Protoplophoridae although this is not reflected in the classification by Balogh (1972). Regarding the relationship of the Sphaerochthoniidae and Protoplophoridae, the nature of the prehysteronotal fissure is an important character commented on in the remarks on *Sphaerochthonius splendidus*.

The Sphaerochthoniidae includes only a single genus: *Sphaerochthonius* Berlese, 1910a.

SPHAEROCHTHONIUS Berlese

Sphaerochthonius Berlese, 1910: 223. Type designation (original): "*Hypochthonius splendidus* Berl.".

Type-species: *Sphaerochtonius splendidus* (Berlese, 1904: 26).

Diagnosis: Sphaerochthoniidae (monogeneric).

Distribution: Widespread—Canada (Nn), California (Nc); Brazil (NTc); Ghana (Ew); Somali (Ee); Caucasus, Crimea (Pe); Algeria, Greece, Italy, Morocco (Pm); Japan (Pc); Java (Om); Komodo Island (Am); South Australia (Aa).

Remarks: Sphaerochthonius is an easily recognisable genus, but delineating the included species is difficult. The unusually small specimen before me has been placed in the type-species, *S. splendidus*, which was originally described from the Mediterranean region. The reason for this placement is partly because the poor descriptions of a long established species make it less exclusive. In order to give some idea of the degree of similarity of the South Australian specimen to other species, I have given a short description of the other species.

In describing *S. suzukii*, Aoki (1977) has reviewed the genus, especially with regard to the form of the somal setae. In referring to hysteronotal setae *J*2 and *Z*2 (as *d*1 and *d*2), he regards the fact that they are short and simple as diagnostic of *S. suzukii*. In fact this attribute is true for the South Australian specimen, the larva of an unnamed species (Grandjean 1934: fig. 2) and for *S. sublanatus* (Mahunka 1977a: fig. 7). In the case of *S. sublanatus* and *S. suzukii*, the mite drawn is slightly squashed and the anterior hysteronotal fissure (*TB*1) has opened up so that setae *J*2 and *Z*2 are no longer obscured by the anterior hysteronotal shield. On the illustrated specimen of *S. suzukii*, the second hysteronotal shield (*NS*2) appears fused to shield *NS*3, whilst for *S. sublanatus* it is attached to shield *NS*1. It is likely that in other species where setae *J*2 and *Z*2 are obscured they have not been described and so what Aoki (1977) would regard as setae *J*2 and *Z*2 are in fact *J*3 and *Z*3.

The 7 species included in *Sphaerochthonius* are considered below mainly in alphabetical order but

with *S. splendidus*, in which the South Australian specimens are grouped, last.

Sphaerochthonius gemma (Oudemans)

Hypochthonius gemma Oudemans, 1909: 319.
Sphaerochthonius elegans Berlese, 1910: 266.
Cosmochthonius gemma (Oudemans): Oudemans, 1917: 25.
Sphaerochthonius gemma (Oudemans): van der Hammen, 1959: 26.

All specimens regarded as nymphs since few genital setae and only 1 claw on each of its pretarsi. Length, 268 (ex Java—Om). All illustrated notal setae, except *z*2, T-shaped, ciliate and stick-like. Two branches of hysteronotal setae subequal in length. Setae in hysteronotal ranks, 3, 4 and 5 with horizontal branches directed transversely. Two heavy lines in illustration (Oudemans 1917: fig. 51) run through setae *J*3 and *J*4 and I agree with Grandjean (1932a: 34) that they represent dorsal ridges, because posterior line would otherwise have to be a 4th fissure.

Sphaerochthonius longisetus Mahunka

Sphaerochthonius longisetus Mahunka, 1977a: 256.

Length, 360-374 (ex Komodo Island—Am). Many dorsal setae (*j*1, *j*2, *J*1, *Z*1, *S*1, *S*2, *Z*4, *J*5, *S*5)T-shaped, papillose and leaf-like. Seta *j*1 similar but ciliate. Setae *s*1, ?*s*2, *J*3 and *Z*3 unbranched, papillose and stick-like; seta *J*3 unusually long (about distance between setal bases *Z*1-*Z*2).

Sphaerochthonius phyllophorus Balogh and Mahunka

Sphaerochthonius phyllophorus Balogh and Mahunka, 1969: 32.

Length, 289-319 (ex Brazil—NTb). Setae *J*1, *z*1, *j*2 T-shaped and possible intermediate between stick-like and leaf-like. "Anterior" hysteronotal setae T-shaped, papillose and leaf-like. "Posterior" hysteronotal setae unbranched, papillose and leaf-like.

Sphaerochthonius suzukii Aoki

Sphaerochthonius suzukii Aoki, 1977: 85.

Length, 310 (ex Japan—Pc). Most notal setae ciliate (short, blunt cilia) and stick-like. Setae *j*1, *z*1, *J*1, *Z*1, *S*1, *S*2, *J*5, *Z*5, *S*5, *J*6 T-shaped, whilst *s*1, *j*2, *s*2, *J*3, *Z*3, *Z*4 unbranched. Setae *Z*6 and *S*6, like setae in file *Za*, unbranched, slim with long, tapering cilia. Transverse dorsal ridge passes just posterior to seta *J*3.

Sphaerochthonius transversus Wallwork

Sphaerochthonius transversus Wallwork, 1960: 377.

Length, 256-277 (ex Ghana—Ew). Form of notal setae similar to *S. gemma* , especially since horizontal branches of setae *J*3 and *Z*3 directed transversally (not an artifact, occurs on living specimens) and 2 branches of each seta similar in length. Different, since setae *s*1 and *j*2 unbranched. Apparently dorsal ridge associated with 3rd hysteronotal setal rank, no such ridge associated with 4th rank as on *S. gemma*. Nymphs grouped in this species have long seta *J*3 like *S. longisetus* and may not be conspecific.

Sphaerochthonius wallworki n.sp.

Sphaerochthonius spec. Wallwork, 1960: 382.

Length, 298 (ex Ghana-Ew). As pointed out in original description, this species very similar to *S. gemma*, having 2 transverse dorsal ridges passing along 3rd and 4th hysteronotal setal ranks, and mainly T-shaped, ciliate, stick-like setae. On the other hand, seta *j*2 unbranched and horizontal branches of setae *J*3 and *Z*3 directed longitudinally with shorter anterior branch. Nymph grouped in this species with horizontal branches of setae *J*3 and *Z*3 directed transversely as *S. gemma*. Despite 4 setae in file *Za*, not certain that this nymph belongs to *S. wallworki*.

Sphaerochthonius splendidus (Berlese)

(Fig. 30)

Hypochthonius splendidus Berlese, 1904: 26, fig. 37.
Sphaerochthonius splendidus (Berlese): van der Hammen, 1959: 25.

Adult

Length, 237.5 (1). Hysteronotum light brown, proteronotum mid-brown. Cuticle covered by granulated hyaline adhesive layer. On soma, network of lines (with granules clustered around) encloses 5-sided or 6-sided areas. Granules also clustered around notal setae. Refractile parts (external malae, cheliceral extremities, setae and claws) paler than general integument.

Single specimen illustrated (Fig. 30), slightly squashed by coverslip, but natural body-form laterally compressed like *Phthiracarus* (Holonotina) or *Protoplophora* (this subcohort). Anterior 2 pairs of legs curl up under edges of proteronotum whilst posterior 2 pairs of legs curl up under flaps from pleural shields. Adanal shields may be capable of closing over anal shields. No evidence confirming acutely hinged prehysteronotal fissure, but soma looks capable of folding so that cowl covers genital shield. Anterior transverse hysteronotal fissure (*TB*1) also appears hinged. By squashing mite, second hysteronotal shield (*NS*2—narrow band bearing setae *J*2 and *Z*2) moves backwards from under anterior hysteronotal shield (*NS*1) near level of setae *J*1 and *Z*1 to be exposed at almost level of setae *J*3 and *Z*3. In illustration (Fig. 30), posterior of 4 broken transverse lines appears to represent posterior edge of folded

hyaline membrane between venter of first hysteronotal shield (*NS1*) and anterior edge of second hysteronotal shield (*NS2*). Reticulate hyaline adhesive layer passes unbroken across anterior transverse hysteronotal fissure so that any movement of shields could mean rupturing this layer.

Legs difficult to observe because folded up. Trochanter and femur III and IV similar to *Cosmochthonius*. Pretarsus IV with 3 claws (stout central claw, 2 slim lateral claws). Adanal setae *Za* and hysteronotal setae *J6*, *Z6* and *S6* similar to *J4*. File *Za* includes 4 setae. Single, dense granular bolus present, but no eggs observed inside specimen.

Material examined: One adult (N1979385), grass and moss or litter under *Eucalyptus viminalis*, savannah woodland, Chambers Gully, 12.6.1974, D. C. Lee.

Distribution: Mediterranean-type climate: Italy, Greece (Pm); South Australia (Aa). South Australia: Chambers Gully, savannah woodland, 1 (1/8).

Remarks: The specimen from South Australia, although much smaller than the type (310), can be grouped in *S. splendidus*. Because I have not wished to damage the single specimen, the description is unusually limited. Earlier work on the hysterosomal shields of the adult (Grandjean 1932a) and larva (Grandjean 1934) of a *Sphaerochthonius* species, indicating a hinged first transverse hysteronotal fissure that is folded forward under the anterior shield, is confirmed, which clarifies some of the confusion about hysteronotal fissures resulting from more recent descriptions of *Sphaerochthonius*. Furthermore, the presence or absence of small simple setae in the second hysteronotal rank as attributes to distinguish species can now be seen as resulting from these setae sometimes being hidden. Unfortunately, I have not established whether or not the transverse prehysteronotal fissure is acutely hinged or not. If the proteronotum can be folded right down, distinguishing the Cosmochthonioidea from the Protoplophoroidea may not be tenable.

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